UNIVERSITY OF MIAMI

Marine Laboratory

PROCEEDINGS

OF THE

Gulf and Caribbean Fisheries Institute

ELEVENTH ANNUAL SESSION

MIAMI BEACH, FLORIDA · NOVEMBER, 1958

Edited by C. P. IDYLL

CORAL GABLES, FLORIDA JUNE, 1959

Gulf and Caribbean Fisheries Institute

Executive Committee

F. G. WALTON SMITH—*Chairman; Director, The Marine Laboratory, University of Miami*

C. P. IDYLL—*Executive Secretary; The Marine Laboratory, University of Miami*

FRANCIS WM. TAYLOR—*President, Warren Fish Company, Pensacola, Florida*

A. J. ROBIDA—*President, Florida Fish Distributors, Inc., Jacksonville, Florida*

DUDLEY WILES—*Fishery Officer, Department of Science and Agriculture, Barbados, B.W.I.*

LAWRENCE W. STRASBURGER—*New Orleans, Louisiana*

JOHN ROBAS—*Fernandina Beach, Florida*

HECTOR FERREIRA—*President, Pesquera e Industrializadora de Guaymas, S. A., Guaymas, Sonora, Mexico*

HARRY F. SAHLMAN—*President, H. F. Sahlman Seafoods Co., Fernandina Beach, Florida*

L. C. RINGHAVER—*President, Diesel Engine Sales, St. Augustine, Florida*

RICHARD T. WHITELEATHER—*Fish and Wildlife Service, St. Petersburg Beach, Florida*

JOHN C. FERGUSON—*St. George Packing Co., Ft. Myers, Florida*

JOHN MEHOS—*Liberty Corporations, Galveston, Texas*

Additional copies may be obtained from The Gulf and Caribbean Fisheries Institute, The Marine Laboratory, University of Miami, 1 Rickenbacker Causeway, Miami 49, Florida, for $2.00 (Two dollars) per copy.

Contents

Shrimp Session

Marking Shrimp With Biological Stains, Thomas J. Costello 1

Fish Inspection in Canada, H. V. Dempsey 6

The Territorial Waters Dispute and the Shrimp Industry, William R. Neblett 10

Research on the Shrimp Fishery of Panama, Juan Obarrio 15

Discussion, Shrimp Session 18

Industrial Fisheries Session

The New Industrial Fisheries Industry of the North Central Gulf of Mexico Area, Travis D. Love and M. H. Thompson 24

Recent Accomplishments in the Fish Oil Utilization Program, Jack Holston 34

Exploratory Fishing for Sardine-Like Fishes in the Gulf of Mexico, John R. Thompson 38

The Role of the Estuary in the Life History and Biology of Atlantic Menhaden, Fred C. June and J. Lockwood Chamberlin 41

New Purse Seining Techniques in the Menhaden Fishery Employing the Power Block, Peter G. Schmidt, Jr. 46

The Use of Electricity in Commercial Fishing in the Sea, Conradin O. Kreutzer 50

Discussion, Industrial Fisheries Session 53

Fish Merchandising Session

Selling Fish with "Point-of-Purchase" Advertising, O. H. Stark 59

What Research Can Contribute to Fish Marketing, W. R. Simmons 61

Solving Problems in National Merchandising of Seafoods, Edward Kausnicka 62

The Kind of Promotion that Food Editors Like, Jeanne Voltz 65

Discussion, Fish Merchandising Session 68

Biological Session

Parasites and Fishery Problems, William J. Hargis, Jr. 70
A New Fishery for Scallops in Western Florida, Harvey R. Bullis, Jr. and Robert M. Ingle 75
Improved Techniques for Collecting Seed Oysters in the Chesapeake Area, David H. Wallace 79
Progress in Atlantic Coast Shad Investigations—Migration, James E. Sykes and Gerald B. Talbot 82
Techniques Used in the Tagging of Yellowfin and Skipjack Tunas in the Eastern Tropical Pacific Ocean During 1955-1957, Gordon C. Broadhead 91
Accumulation of Radioactive Materials by Fishery Organisms, Walter A. Chipman 97
Discussion, Biological Session 110

Caribbean and General Session

The Recreational Potential of Marine Fisheries, Daniel H. Janzen 116
Canning Tuna in Puerto Rico, Rolf Juhl 120
Haiti's Fisheries and Their Potential Development, Martin H. Routh 123
Experimental Trawling for Red Snapper, Warren F. Rathjen 128
Laboratory Experiments on Raising Tilapia Mossambica in Salt Water, Jacques S. Zaneveld 132
Research and Interpretation of Marine Areas of the U. S. National Park Service, Orthello L. Wallis 134
Discussion, Caribbean and General Session 138
Participants 143

Richard A. Kahn

The Proceedings of the 11th Session of the Gulf and Caribbean Fisheries Institute are respectfully dedicated to the memory of Dr. Richard A. Kahn, who died suddenly in August, 1958. Together with Dr. F. G. Walton Smith, Dr. Kahn organized the Institute in 1948, and he served as a member of the Advisory Committee from that time until his death. His wealth of ideas, his wide knowledge of the fisheries industry and his great drive were major factors in the successful growth of the Institute over the years.

Acknowledgments

The Gulf and Caribbean Fisheries Institute is a non-profit organization supported mostly by The Marine Laboratory of the University of Miami. Additional services, including some of the costs of publishing the Proceedings, are only possible through the generosity of the fishing industry. The following persons and organizations contributed financial help during the past year, and this is gratefully acknowledged.

Irving Usen, O'Donnell-Usen Fisheries Corp., Boston, Mass.; Harvey Smith, The Fish Meal Co., Beaufort, N. C.; James B. Hardee, Standard Marine Supply Co., Tampa and Fort Myers, Fla.; I. W. Hardee, Jr., Standard Marine Supply Co., Key West and Standard Hardware Co., Fernandina Beach, Fla.; Leo D. Levinson, Ocean Products, Inc., Tampa, Fla.; Heber Bell, H. Harry Bell & Son, Pass-a-Grille, Fla.; Otis Smith, Fish Products Co., Lewes, Del.; Gilbert P. Smith, Atlantic Processing Co., Amagansett, N. Y.; Barton S. Udell, Gulf Stream Quick Frozen Foods, Inc., Miami, Fla.; J. Rubenstein, Rubenstein & Sons, Inc., Dallas, Tex.; Crosby Field, FlakIce Corporation, Brooklyn, N. Y.; Max Swartz, East Coast Fisheries, Miami, Fla.; R. Amerio, Amerio Contact Freezers, Cliffside, N. J.; Henry Ambos, Trade Winds Co., Thunderbolt, Ga.; Stanley Letson, Maine Marine Products, Inc., Portland, Me.; A. B. Tippit, T. & T. Shrimp Co., Port Lavaca, Texas; S. A. Key, Key Fish Co., Port Lavaca, Texas; E. N. Dumas, Daniel & Dumas Seafoods, Port Lavaca, Texas; J. H. Clegg, Jr., Clegg Shrimp Co., Port Lavaca, Texas; John Ferguson, St. George Packing Co., Fort Myers, Florida; L. C. Ringhaver, Diesel Engine Sales, Inc., St. Augustine, Fla.; Jack Silverman, Modern Maid Food Products, Inc., Jamaica, N. Y.; Fernand Lapeyre, The Peelers Co., New Orleans, La.; Jack T. Styron, Wallace Menhaden Products, Inc., New Orleans, La.; John H. Rosenberg, Florida Fishermen's Supply Co., Tampa, Fla.; Raymond Lee Haynie, Keedville Oil and Guano Co. Inc., Wildwood, N. J.

MONDAY—NOVEMBER 17

Chairman—JOHN MEHOS, *President, Shrimp Association of the Americas; Liberty Corporations, Galveston, Texas*

Marking Shrimp With Biological Stains

THOMAS J. COSTELLO
U. S. Fish and Wildlife Service
Coral Gables, Fla.

THE U. S. FISH AND WILDLIFE SERVICE initiated tests in 1954 to find a more suitable method for marking shrimp, since mechanical tags had demonstrated severe limitations. As a result, Dawson (1957) reported notable success using biological stains as marking agents in three species of penaeid shrimp.

The use of stains for marking living organisms is not a new device or idea. Loosanoff (1937), Vernon (1937), Feder (1955), and others have reported success in staining various marine animals. Chapman (1957) reported successful use of a trypan blue and titanium dioxide mixture in marking juvenile steelhead, *Salmo gairdneri.* Slack (1955) used machine ink to mark crayfish. Menzel (1955) successfully stained white shrimp, *Penaeus setiferus,* with fast green, one of the stains used by Dawson. Racek (1955) found a method of staining penaeid prawns by immersion in Nile blue sulfate.

Dawson's work is of particular interest because of the stain longevity in living animals. Trypan red and trypan blue stains remained fast and recognizable for over two hundred days. This, and his report of relatively low mortality incident to staining, makes his technique a promising tool with which to study these commercially important crustaceans.

Dawson's work was confined to laboratory experimentation. The problem remained to adapt his technique for field use and to determine whether these stains would remain fast and recognizable under natural conditions. Biscayne Bay, Florida, was chosen as a site for releasing a sizable group of stained pink shrimp, *Penaeus duorarum,* into an operating fishery. The purposes of this initial field experiment were:

(1) To test the longevity of stains under natural conditions.
(2) To learn how rapidly shrimp could be stained and what equipment is necessary to stain shrimp in large quantities.
(3) To learn how readily stained shrimp would be recognized when recaptured in the fishery.
(4) To study the movement of stained shrimp within the Biscayne Bay area.

The Biscayne Bay Fishery

The waters of Biscayne Bay support a sizable bait fishery, with six to eleven boats operating under permits issued by the Florida State Board of Conservation. The shrimping is confined to a regulatory area (Figure 1) and sale of shrimp taken in this area is for bait purposes only. Higman (1952) and Sieben-

aler (1953) present a history of this fishery, which has been in operation since about 1952.

Prior to May 19, 1958, shrimp were taken in Biscayne Bay by otter trawls and rigid roller-frame trawls. After this date shrimping was restricted by the Florida State Board of Conservation to use of rigid roller-frame trawls only. Channel wing nets are legal and are occasionally used, but they are of minor importance in the bait fishery. Tabb (1958) summarizes the status of this fishery.

Equipment was designed which was portable and could be utilized for subsequent staining experiments. Equipment included a wall tent which housed a staining table and two large plywood shrimp-holding boxes. The larger box, 6 by 2 by 3 feet deep, supplied with running sea water is capable of holding three to four thousand shrimp for staining over a period of six to eight hours. The smaller box, 2 by 4 by 2 feet deep, served as the receptacle for shrimp which had been stained and placed in a trough of running sea water built into the staining table.

A gasoline operated pump furnished sea water at sixteen gallons per minute to the boxes and staining table during the time staining was in progress. As needed, shrimp were dipped out of the large holding box and placed in 12 by 14 inch plastic inserts built into the staining table. Stained shrimp placed in the trough of running sea water flowed down and dropped into a live car. When the live car contained approximately 500 stained shrimp it was taken out and anchored a short distance off the beach ready for transporting to the release site six miles to the south in Biscayne Bay.

Stains and Minor Equipment

Fast green is considerably less toxic than the other three usable stains noted by Dawson and was chosen for the initial work on that basis. All shrimp were stained by injection with a 1 per cent solution of fast green[1], dissolved in artificial sea water (Subow 1931) containing only the essential inorganic salts. Tests indicated artificial sea water is a superior solvent to the filtered natural sea water used by Dawson (1957).

Tuberculin syringes, one quarter cc., half cc., and one cc., were tested throughout staining. The half cc. syringes are superior for this work. No. 27, quarter inch needles proved the most satisfactory of several gauges and lengths tested. Multi-dosage syringes proved of no practical value.

Speed of Staining

Twenty-one students and members of the regular staff of the University of Miami Marine Laboratory participated in the staining phase. We found that anyone without previous experience but with normal finger dexterity can stain 200 to 240 shrimp per hour.

The Staining Operation

Table 1 contains a summary of the staining operation. At the University of Miami Marine Laboratory, Virginia Key, a total of 20,080 individuals, mean carapace length 19.1 mm, were stained between April 24 and May 29, 1958. Shrimp were taken in Biscayne Bay in rigid roller-frame trawls the night before

[1]The disodium salt of p,p′— dibenzyldiethyldiamino—p″—hydroxytriphenyl-carbinol trisulfonic acid anyhydride (manufacturer National Aniline Co.).

staining. High winds and inclement weather during the period kept bait shrimp boats ashore for periods of from three to nine days. Thus an operation which could have been accomplished in five to seven days covered a thirty-six day period.

Release of Stained Shrimp

Rounsefell and Kask (1943) stated that one-at-a-time releases "soon result in a ring of predators waiting to gobble up each fish." They recommend releases as a school unit—our experience demonstrated the wisdom of this method. Releases in units of 500 were made in thirteen different locations in Biscayne Bay along a line from Matheson Hammock Beach to Southwest Point on Key Biscayne.

TABLE 1

SUMMARY OF BISCAYNE BAY SHRIMP MARKING

Shrimp Marked			*Shrimp Recovered*			
		Mortality	[1]Verified		[1]Unverified	
Date	Number	in 6 hrs.	Date	Number	Date	Number
4/24	1100	43	5/1	1	5/6	2
4/28	1000	52	5/3	1	5/7	1
4/29	1500	61	5/9	1	5/11	3
4/30	2000	68	5/10	1	5/18	1
5/5	2380	81	5/19	1	5/22	4
5/13	1000	44	5/22	3	5/25	1
5/19	1000	31	5/23	4	6/2	7
5/21	2000	54	5/24	5	6/5	2
5/22	1000	43	5/25	1	6/8	1
5/26	1000	31	5/26	2	6/13	1
5/27	2000	62	5/27	6	6/15	9
5/28	1000	51	6/1	2	6/16	4
5/29	3100	101	6/6	5	6/18	6
			6/9	1	6/19	8
	20,080	722	6/10	2	6/20	1
			6/11	1		
			6/12	2	Total..	51
			6/14	6		
			6/15	2		
			6/16	2		
			6/17	2		
			6/21	1		
			6/29	4		
			7/5	1		
			Total....	57		

Movement of Stained Shrimp

Figure 1 summarizes movement of stained shrimp recovered by the bait fishery. It is of interest to note that nearly all of the movement was to the north toward Bear Cut and the Dodge Islands. This movement agrees with the

[1]Verified recoveries include shrimp taken in the fishery, returned, and identified; unverified recoveries include reports by fishermen of stained shrimp noted, but not actually returned for verification.

impression of bait fishermen that pink shrimp populations move out of nursery areas which are to the south, into the areas of grass. Probably as they reach a larger size, they move into the area of mud bottom and from there into the ocean through Bear Cut and Government Cut.

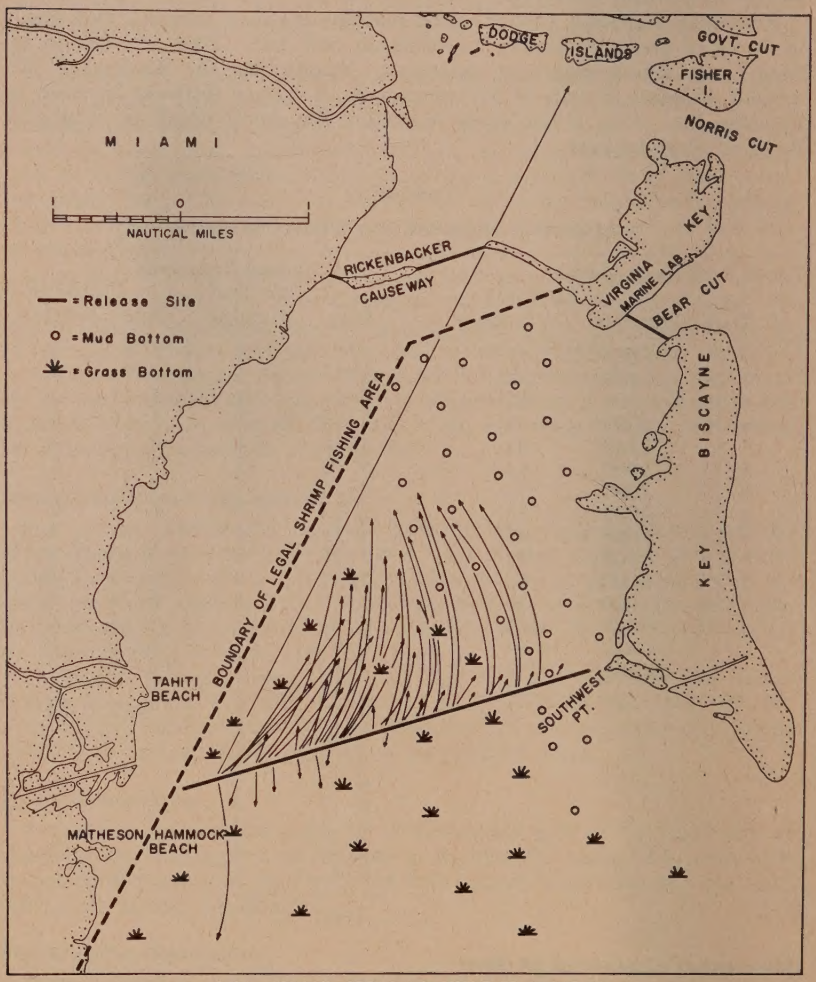

FIG. 1 ARROWS DEPICT MOVEMENT OF INDIVIDUAL SHRIMP FROM RELEASE SITE TO POINT OF RECAPTURE.

Analysis of shrimp recoveries required a knowledge of fishing effort with respect to the release site. Periodic observations of the nightly fishing and in-

terviews of bait fishermen indicated fishing effort north and south of the release site was approximately equal.

Recovery of Marked Shrimp

Table 1 summarizes reports of stained shrimp recovered in Biscayne Bay. A total of 108 stained shrimp were reported taken by bait fishermen, 0.5 per cent of the 19,358 released alive. Fifty-seven of this number were verified by actual return of the stained animals. Several comments are pertinent here:

(1) Lack of personnel limited the coverage of landings in Biscayne Bay.

(2) All shrimp recovered, including the last five verified recoveries June 29 and July 5, remained clearly marked, with no detectable fading in the stained area.

(3) Because of the manner in which live shrimp for bait purposes are handled, it is difficult to note stained shrimp passing through a bait fishery. The live animals are handled rapidly in the early morning hours to insure delivery in good condition to retail bait houses.

(4) It was difficult to keep an active interest among bait fishermen for this project, yet we obtained reasonably good information on the actual point of capture for most verified recoveries.

(5) Biscayne Bay was closed to otter trawl fishing May 19 (rigid roller-frame shrimping continued as usual). This probably materially reduced the number of stained shrimp recoveries. Since there was clearly a general movement of shrimp northward in the Bay, shrimp with a long "out time" simply were unavailable when they reached the mud bottom area of the Bay where otter trawls had normally fished.

Conclusions

(1) Fast green can be used successfully to mark pink shrimp in a bait fishery.

(2) Stained animals were readily recognized but recovery requires more effort than would be needed for shrimp tagged with a mechanical device.

(3) Shrimp recovered with a maximum possible "out time" of 73 days and a minimum of 37 days showed no evidence of stain fading. It is reasonable to assume that this stain will be recognizable over a considerably longer period than has been demonstrated here.

(4) Large quantities of shrimp may be easily stained without prohibitive mortality by inexperienced personnel.

(5) General movement of shrimp in Biscayne Bay, Florida, for the period covered was north and northeastward toward outlets to the ocean.

(6) There is presently no commercial fishery for pink shrimp in areas contiguous to Biscayne Bay. Although some effort for recovery of stained shrimp was made in the lower Keys and Tortugas fishery, no stained shrimp from Biscayne Bay were recovered. This lends some evidence that Biscayne Bay populations are not subject to exploitation in their mature stages.

ACKNOWLEDGMENTS

Grateful acknowledgment is made to students and members of the University of Miami Marine Laboratory staff for participation in the staining phase of this experiment. The author is also indebted to Mr. Robert Still of Miami for advice and help in handling shrimp preparatory to staining.

REFERENCES

Chapman, D. W.
1957. Use of latex injections to mark juvenile steelhead. Progr. Fish.-Cult. *19* (2): 95-96.

Dawson, C. E
1957. Studies on the marking of commercial shrimp with biological stains. Spec. sci. Rep. U.S. Fish Wildl. Serv.—Fisheries No. 231, 23 pp.

Feder, H. M.
1955. The use of vital stains in marking Pacific coast starfish. Calif. Fish Game *41* (3): 245-246.

Higman, J. B.
1952. Preliminary investigations of the live bait shrimp fishery of Florida Bay and the Keys. Fla. St. Bd. Conserv. Marine Lab., U. of Miami, (mimeo. rept.) 52-20. 8 pp.

Loosanoff, V. L.
1937. Use of Nile blue sulfate in marking starfish. Science *85* (2208): 412.

Menzel, R.W.
1955. Marking of shrimp. Science *121* (3143): 446.

Racek, A. A.
1955. Penaeid prawn fisheries of Australia with special reference to New South Wales. Indo-Pacific Fish. Council 6th Session, c 55/SYM 3. 18 pp

Rounsefell, George A. and J. L. Kask
1943. How to mark fish. Trans. Amer. Fish. Soc. *73*: 321-363.

Siebenaler, J. B.
1953. The Biscayne Bay commercial fishery. State Board of Conservation. Marine Lab., U. of Miami. Tech. Ser. No. 6, 9 pp.

Slack, Keith W.
1955. An injection method for marking crayfish. Progr. Fish.-Cult. *17* (1): 36-38.

Subow, N. N.
1931. Oceanographic tables U.S.S.R. Oceanogr. Inst. Hydromet. Com. Moscow. 208 pp.

Tabb, Durbin C.
1958. Report on the bait shrimp fishery of Biscayne Bay, Miami, Florida. Fla. St. Bd. of Conserv., Marine Lab., U. of Miami, (mimeo. rep.).

Vernon, A. A.
1937. Starfish stains. Science *86* (2220): 64.

Fish Inspection in Canada

H. V. Dempsey

Director, Inspection and Consumer Service
Department of Fisheries, Ottawa, Canada

About fifty years ago the Government of Canada set sail into the uncharted sea of fish inspection. During periods of temporary doldrums, succeeding gen-

erations of fishery administrators frequently have wondered if the ship should have left port. Such periods, however, are fleeting, since most people in fish inspection work are dedicated optimists. They must be in order to survive.

Initially, fish inspection in Canada was restricted to pickled fish, such as herring and mackerel, on the Atlantic coast. There was no uniformity in the cure or packing of this valuable export item with the result that Canadian shippers had difficulty in competing successfully in traditional markets with those countries where standardization of the product was in effect. Experts in the manufacture of pickled fish were brought to Canada from Britain, who, after a period of study, recommended standards for the product and for the barrels in which it was packed. These standards were promulgated by law. Of interest is the fact that the administrators of that time quickly found that education and demonstration at the primary producer level were required to make the grading program successful. It was as true fifty years ago as it is today that fish inspection cannot be made to work by the simple passage of laws and their enforcement by a staff of officers.

As the years passed other fisheries products were added to the inspection legislation. In most instances it appears that the grades and standards which were established for each new commodity were designed to assist in orderly export marketing. Canada, as you may know, exports over two-thirds of her fisheries products.

The first canned fish to be placed under compulsory inspection was Pacific salmon, about twenty-five years ago. Over the years, with some minor modifications and improved techniques, canned salmon inspection has proved most successful, both in the view of the consumer and of the industry.

More recently, fresh and frozen lobster meat were added to the list of fishery products under systematic inspection controls. Lobster forms one of the most valuable fisheries of the Atlantic coast. Cooked lobster meat is particularly subject at the processing level to contamination by bacteria of public health significance. Strict bacteriological standards are maintained in the processing plants and daily samples of the product are taken to ensure that it is of good quality and that suitable levels of sanitation exist.

Fish inspection in Canada was given considerable impetus during World War II and the years immediately following, because of the certification required by the British Ministry of Food for all purchases of fish products, including pickled and salted fish, frozen fish, and canned fish. Similar certification was required for fish purchased by UNRRA. During the years 1945 to 1949 there was a great increase in the numbers of fisheries officers whose primary task was that of inspection. In addition, union of Newfoundland with Canada in 1949 further augmented the inspection service with a substantial number of highly experienced, well-trained inspectors from that historic old island.

A successful field inspector of fish products must be highly skilled in the art of subjective judgment. The limitations of time and distance do not permit the maximum utilization of facilities which may be available for the objective assessment of the quality of the product. However, an inspection service must be supported by adequate numbers of competent chemists, bacteriologists and technicians with suitable laboratory facilities for standards development, sanitary surveys, staff training and other routine functions. The laboratory service may also act as a referee in the event of appeals by industry against the decision of an inspector and in certain marketing disputes.

In the early stages of growing inspection demands during and immediately following the last war, standards development and the establishment of objective criteria was a temporary function of the Fisheries Research Board of Canada or of scientists seconded from that service, for certain specific tasks. Gradually, however, the Canadian Department of Fisheries developed its own laboratory staffs and facilities. Today, it may fairly be said that the tremendously valuable work being done by the Fisheries Research Board in the field of pure research on fish spoilage and allied problems provides much of the lifeblood necessary to the Inspection Service laboratories in the field of application.

Before proceeding to a review of recent developments in fish inspection, I should like to end this short summary of the history of the Inspection Service by saying that, during the current fiscal year of 1958-59, the Inspection Service of the Department of Fisheries is made up of 210 inspectors and administrators at some 125 inspection offices and headquarters across Canada, together with 62 chemists, bacteriologists and technicians operating out of eight permanent laboratories, three land based mobile laboratories and one seventy-foot inspection vessel with complete laboratory facilities. The total current budget for this Service is $1,450,000.

I should like now to deal with one aspect of our work which, for the past three or four years, has engaged our closest attention and most concentrated effort. I refer to the development of systematic inspection procedures for whole and processed fresh and frozen fish and processing plants. The rapid developments during the past fifteen years in the technology of food production and processing and quality control procedures have not been shared by some branches of the fishing industry. This is particularly true insofar as it relates to the quality of the raw material landed by the fisherman and to the subsequent processing of that raw material into a form suitable for merchandising to the consumer. The phenomenal growth during the past decade in Canada and the United States of mass merchandising methods through supermarkets has created a significant new pattern of consumer demands and preferences. The modern housewife has been trained to expect to find attractively packaged, easily prepared foods of consistently good quality displayed for her selection. It is, I think, this last requirement of "consistently good quality" which often places fresh and frozen packaged fish in disfavor, a fact which is partially reflected in the low per capita fish consumption of both Canada and the United States. It has been said that North Americans are basically meat eaters, but I do not hold completely with this view. I prefer to believe that the statement is incomplete and that it might be closer to the truth if a few words were added and one was to say: "North Americans are primarily meat eaters because they are not able always to purchase fish and shellfish of consistently good quality."

Recognizing the changing pattern of consumer buying habits and the decline in the national consumption of fish, the fishing industry of Canada asked the Department of Fisheries several years ago to investigate the possibility of developing a systematic inspection program for fresh and frozen fish.

In order to assess the extent of the problem, the Department, with the cooperation of the Fisheries Research Board, conducted a physical survey in late 1953 and early 1954 of all fish processing plants in Canada including cold storage facilities. Over six hundred plants were surveyed from coast to coast by teams of scientists and inspectors over a three month period. No attempt was made at that time to assess the quality of the product itself. At the conclusion

of the survey the teams, totalling over thirty men, were brought to Ottawa to make an overall assessment of the survey data. Sub-committees were then formed and charged with the task of developing minimum standards for processing plants under the headings of construction, equipment, sanitation and operation. A fifth sub-committee was given the complex task of defining minimum quality standards for fresh and frozen fish and for the care and handling of the product.

The first draft standards had, perhaps, an idealistic tinge, but subsequent discussions of the proposed standards with industry very quickly evolved practical requirements which did not sacrifice high standards of quality and sanitation.

Once the standards were formulated the next and by far the most difficult task was the training of field inspectors. Training in plant assessment and inspection, while complex, was relatively straight-forward. The development of uniform levels of subjectivity in assessing the quality of fresh fish as landed from the vessels was, however, an entirely different matter. Unfortunately, there was an almost complete absence of objective measurements of quality which could be applied equally to all species of fish. On the other hand, work done by Castell and his associates at the Fisheries Research Board Station in Halifax had indicated that trimethylamine might serve as a useful indicator in measuring spoilage in the muscle of cod, haddock and other Atlantic species.

The training of the inspection staff in Newfoundland and the Maritime Provinces in fresh fish inspection began about three years ago and is still in progress. Not more than fifteen officers must comprise the group under instruction if each man is to be given the individual attention required for the satisfactory development of his subjective judgment. Each course is of about three weeks duration, with lectures during the morning on the chemistry and bacteriology of fish spoilage, plant sanitation, inspection techniques and allied subjects, while the afternoons are devoted entirely to the physical grading of fish of varying degrees of spoilage. Each officer individually grades hundreds of fish during the course. At the same time, the Laboratory conducts objective measurements of spoilage on the fish so graded and correlates these with the subjective judgment of the inspector. A most satisfactory level of uniform accuracy on the part of the inspectors is usually found by the end of the course.

At the end of the training period the officer returns to his field headquarters where he works for a time with and under the supervision of an experienced officer. He assists in the grading of fish as it is being discharged from trawlers and other vessels and weekly samples of the fish graded by him are forwarded to one of the laboratories for objective examination. It has been found that, after five or six months in the field, an officer's judgment may begin to slip and a refresher course is necessary. Such refresher courses are found not to require the same length of time as that for the original training groups.

Similar training courses are being conducted in the freshwater fishing provinces and in British Columbia. These courses are proceeding rather more slowly in view of the fact that no satisfactory objective measurement of spoilage has yet been established for lake fish or for the major commercial species from the Pacific which enter into the fresh and frozen fish trade. With the important exception of having an objective check on the subjective judgment of the inspectors, the courses follow the same pattern as in the Atlantic Provinces.

As a result of the experience gained by the Inspection Service over the past several years in the voluntary grading of fresh fish as landed at the wharf, the

Department, with the concurrence of the Canadian fishing industry, has recently announced its intention to provide national inspection of fresh and frozen fish and processing plants. Before Department inspection will be given any fresh or frozen fish products, the processing plant itself must meet specific requirements as they pertain to construction, sanitation, operation and equipment. Once the plant has been approved by the Department, under established standards, the following fish products will be eligible for inspection: round and dressed fish, fillets, steaks, fish sticks and similar portions. If a frozen fish product complies with clearly defined quality, processing and labelling specifications, the packer may identify his product with the designation "Canada Inspected" within a line drawing of a mapleleaf marked on the wrappers, labels, containers or, where practicable, on the whole fish. Inspected fish which is to be marketed in the fresh state as whole fish, fillets or steaks, may be identified by having the words "Processed Under Government Supervision" within a line drawing of a mapleleaf marked on their wrappers, labels or containers.

This program does not contemplate inspection beyond the processing plant level. For this reason it was felt to be the course of wisdom to use a less comprehensive quality designation on fresh fish products.

The standards for fresh and frozen fish products and the processing plants were developed in close consultation with industry and, I think, represent a satisfactory compromise between what is ideal and what is practical, keeping in mind the present day demands of the consumer. Both the Department and the fishing industry are confident of a favorable consumer response to this progressive step of making available in the retail stores both fresh and frozen fish products prepared under most rigid sanitary requirements, which possess all of the factors of high quality demanded by the discriminating buyer of today.

In order for an inspection program to be successful it must apply to the product from the raw material stage through the chain of processing and distribution to the retail level. Before too many years have passed the Department of Fisheries hopes to be in a position to offer the retailers and the consumers an inspection system to deal directly with fish quality at the time of display at the retail level. This is a tremendous and complex undertaking which will begin with inspection and grading at the wharf followed by rigid control of processing, cool and frozen storage, maximum storage periods, transport, and, finally, a reasonably systematic check of the product at the retail level. We all realize that much of the careful effort expended by the primary processing industry in quality control is often nullified by careless merchandising and storage at the retail outlets. Accordingly, much education work must be done through retail trade organizations and with as many individual stores and supermarkets as can be covered with the staff available. It is a project which will make heavy demands on the time and energy of the staff and give rise to many frustrations before satisfactory results are achieved. However, we are confident of success.

The Territorial Waters Dispute and the Shrimp Industry

WILLIAM R. NEBLETT
Executive Director, National Shrimp Congress

HAVING BEEN so close to the Tortugas shrimp fishery since its inception, and being a resident of Key West, it is heartening to hear of the advances made in

biological research in that area. As the state senator for the 24th District, in 1957 I passed the legislation under which the Conservation Department now controls the Tortugas area, and I am happy that the scientists are learning so much about the fishery that substantiates the need for such regulations.

Some of my information and interest in this fishery came about in 1953 and 1954, when I was the owner of a 57 foot shrimp fishing boat. These experiences keep me keenly aware of many of the problems confronting the owners and operators of fishing vessels including, but not limited to, such perils of the sea as collisions and sinkings, and such problems of operation as repairs and incompetent crews.

The unique problems of fishing are greatly complicated by the fact that most fishing is done on the high seas or within x miles of other countries, and the captain must determine just how many miles from the shore his vessel may fish without becoming subject to the further peril of seizure. Immediately he is involved in that most controversial of all matters—international relations. For the high seas are the undivided property—the highways—of all nations in their surface areas, and communal property to their very deeps. Thus, each nation, however tiny, has a voice and a vote in the disposition of the treasures of the sea. We come at once to grips with the interest of the Littoral, or Coastal State, as against the Fishing State, with its fishing fleets close to the shores of the Coastal State. The problem: How close? This is the almost insoluble problem of the width of the Territorial Sea, which is interlocked with the additional problem of the Contiguous Zone, or Fishing Sea.

When 86 states are gathered around the conference table, what makes each nation vote in a certain way on the subject of the Territorial Sea or any other world problem?

In the fisheries division of our Department of State, which has operated in a distinguished fashion these past ten years, there is a *modus operandi* based on the noble premise that if a proposal is just, reasonable, scientifically sound and does the least harm to the most people, that proposal should be advanced on its merits, that we are appealing to the higher civilized instincts of mankind in an enlightened world. This position is worthy of the United States of America, and we are proud to go to the conference table on such a high plane. But even in our democratic government we are aware that before one may become a statesman he must be a politician. The two are interwoven and inseparable. This is also true at the world level. The leaders or rulers of each nation are there because they are pleasing their own people, their constituents, and the first duty of these leaders and rulers is to feed and protect their own people.

Thus the internal affairs of each nation, large or small, primarily determine its conduct and its vote on external or world affairs. Thus we face the fact that the internal affairs of Laos, Cambodia, Algeria and Ghana affect the daily operation of vessels in Fort Myers, Tampa, Galveston and Brownsville.

Man has risen above the beasts (and the fishes) because he has a mind and a will to bring law to an evolving and changing world, so that he will know his rights, duties and liabilities, and be able to live at peace with his neighbor if possible, and know the rules of warfare if he must fight. We are completely ruled by law, and it is significant that when you say the word "Law" you immediately think of "Law and Order." Now the borders of nations are closer than ever in the jet age, and the solutions of problems left pending are imminent and important. Our only forum for these solutions is the United Nations.

The United Nations has not been asleep on these vital matters. The Hague Conference of 1930 failed to reach agreement on the limits of the territorial sea. Wisely, the U. N. directed the formation of the International Law Committee, which for eight years held hearings and studied the Law of the Sea in all of its phases. It finally emerged with excellent recommendations which formed the Agenda for the U. N. Conference on Law of the Sea held this year at Geneva, from February 24, through April 27. Eighty-six nations participated. There were five accredited fisheries advisors to the State Department, including the writer, and two others attended for partial periods. They represented every segment of U. S. fisheries.

The Gulf shrimp industry made notable gains at this Conference. When you hold your own at an international conference you have achieved something. When you better your position, it's time for a celebration. But let us heed a word of warning. There is nothing static or fixed in any world position; it is a fluid thing like jelly or quicksilver; it must be constantly guarded and contained. General agreement on a particular convention or treaty may be reached and then there may be failure to obtain enough signatories ratifying without crippling reservations to make that document effective.

But progress at the world conference level is still progress.

Recall my earlier remarks about the Coastal State and the Fishing State. The United States is really both; we fish our own coastal waters intensively and we roam afield in tuna, shrimp and other fisheries. This dual interest helps a little to understand both sides of the matter.

At this point let us also think of the problems of some of the smaller coastal states whose resources do not include large, modern fishing fleets; who say they need the protein of nearby fish stocks to feed their people; who stand on their dignity and rights as sovereign members of the community of nations, and whose political leaders must think of world problems as they affect internal affairs, not necessarily from an informed scientific viewpoint, but as a sounding board for the mass thinking of their people.

It is obvious that stocks of fish should be fished to the greatest extent possible consistent with the maximum sustainable yield, as determined by scientific study for sound conservation. The world needs this food, this oil, this rich harvest. The question is—Who does the harvesting?

The discussions of the U. N. Conference on Law of the Sea were divided into five committees. Committee V, on land-locked countries, does not concern us here, although remember that these land-locked countries also exercised their right to vote on sea-going matters. Committee II discussed the Regime of the High Seas, and this touches on our going and coming over the waters. Committee IV discussed the new problems of the Continental Shelf; new because the doctrine had its inception in the Truman Proclamation of 1945. Here we passed our first obstacle.

Should crustacea (shrimp) be considered a part of the continental shelf? What animals belong to the shelf? Should it go so far as to include pelagic fish?

It takes but a few seconds to say that we won our position that shrimp should not be considered as belonging to the shelf. But between close, even tie votes, in Committee IV and motions in plenary, there were five anxious weeks of guarding against possible combinations that would distort this position by improper modification.

Committee III, on Fisheries, was another problem. Many nations tried delay-

ing tactics in an effort to link proceedings with the problem of the Territorial Sea which was the bone of contention in Committee I. Here was done the most heroic work of our State Department fisheries people, with the result that there is a delicately balanced convention which gives coastal states additional rights but protects the interests of the fishing states if those rights are not properly exercised by requiring compulsory arbitration. Here, too, is a fair document which helps our shrimp fishing industry provided it does not become, in the course of ratification, too riddled with reservations.

Where do we stand with regard to the territorial sea now? Like the Hague Conference of 1930, Geneva of 1958 did not resolve the problem, but some advances were made. The conferees knew from the outset that this would be the most controversial of all subjects discussed, so it was saved to the final days, and there was even an extension of two days made because the debate and the voting on the territorial sea was so prolonged.

It is so evident that extreme viewpoints are involved that we shall confine ourselves here to a few vital factual results:

(1) It is tacitly admitted now that claims beyond twelve miles, such as advanced by Peru, Ecuador and Chile, were rejected.

(2) The Soviet bloc and a few other nations are solidly committed to a 12 mile zone.

(3) The United States and the European nations, long exponents of a three-mile limit, showed a realization of a changing world, and a genuine desire to compromise by proposing a six-mile territorial sea, plus a fishing zone of an additional six miles, preserving historic fishing rights.

(4) India, Mexico and others, in a different type of compromise, proposed an elastic territorial sea, to be set by each nation, somewhere between three and twelve miles. The difficulty here is that there would really be no standard, and this proposal would tend to bless further unilateral acts by nations, a procedure to be avoided. Furthermore, the practical effect of this proposal is twelve miles.

None of these proposals won the necessary two-thirds vote, but the U. S. proposal did receive the most affirmative votes, the final vote being 45 for, 33 against, with 7 abstentions. The Russian 12-mile proposal was soundly defeated: 21 affirmative, 47 negative and 13 abstentions. The elastic three to twelve mile proposal of India and Mexico received 39 affirmative, 38 negative votes, with 8 abstentions.

We may say fairly now that the preponderance of sentiment was with the U. S. proposal, and we are hopeful that an acceptable formula may be found to define "historic fishing rights" in such a manner as to win a few more votes and attain the two-thirds majority necessary to embody this principle in a Convention.

At Geneva, failing to reach agreement, the Conference recommended to the United Nations that this subject be again considered in the future. We believed that with some time for cooling off, plus further negotiations and appeals to reason by our diplomats throughout the world, a favorable atmosphere for a future conference might be built up. But another failure at Geneva has precipitated matters, and even now it is being discussed at the United Nations in New York.

The powder keg in this instance is Iceland, a nation almost entirely dependent on fisheries for its life and its economy. Fishing is about 90 per cent of Iceland's

business. It is a unique and entirely different situation for fisheries than exists anywhere else in the world. Ordinary rules do not fit Iceland's situation. We had hoped that some provision might be made at Geneva to recognize this situation, but a resolution that might have helped the matter failed of passage. So, acting unilaterally, Iceland declared its own fishing sea, the United Kingdom sent its trawlers accompanied by warships, and there resulted the so-called "codfish war" which has featured prominently in the news. Iceland has appealed to the U.N. for a direct solution to its problem.

The U.N. itself, we believe, is not the proper forum for the resolution of fishery matters, but this is a subject which should again be considered at a conference called especially for this purpose. The statesmen, diplomats and international lawyers at U.N. Headquarters are not equipped with the scientific and biological information so vital to reach proper solutions about fisheries matters. And it is likely that such a conference will again be called, perhaps next August, or early in 1960, although we had hoped that it might be later, because these are troubled times, with many serious non-fishing matters under discussion. But these other problems become interwoven in such a manner as to cloud real issues and cause voting for spite or for trading purposes.

The shrimp fishery has a real interest in all of these matters at the international level. A business man must do the best he can—take advantage of every possible peek into the future—to plan the holding and the development of his business in an intelligent and informed manner. Probably in no other business do there exist as many variables as in the shrimp industry. Stocks of shrimp come and go, sometimes because of improper conservation; sometimes for yet unknown biological reasons. The industry requires large capitalization and brings great benefits from an economic standpoint. Yet it must meet these variables at the international level, plus the perils of the sea, incompetent crews, changing markets—it is a challenge and an adventure as well as a business.

The freedom of the seas for fishing is a time-honored, established principle in the community of nations. The growing populations of the world need the protein content in seafood, a food that supports long life with its lean meat content better than any other source.

Any increase in the Territorial Sea or the so-called Contiguous or Fishing Zone vitally affects the off-shore Gulf shrimp industry, and, from an economic standpoint, all of the shrimp industry in the eastern part of the United States. Should our larger off-shore vessels be precluded from distant fishing they would necessarily then compete with the smaller vessels and smaller nets nearer home ports. Our own shrimp stock will not support such a fleet biologically, nor would it be sound to operate on the reduced catch-per-effort which would then result.

At the business man's level our relations with our neighboring countries have been excellent. The Shrimp Association of the Americas is an outstanding example. That our governments have failed to reach as good an accord is to be deplored. It points up the significant fact that the inter-relation of fishery problems to other world problems, such as defense, provides an atmosphere of difficult negotiation.

Let us hope that science and reason will prevail at the council table, and let us remember that we must play our part on this stage to keep alive and informed—and to carry the message of our needs and problems actively and persuasively to the negotiators of our own country, and, as far as we are able, to our contemporaries in other nations.

Research on the Shrimp Fishery of Panama

JUAN OBARRIO
Director de Pesca, República de Panamá

Introduction

FOR A SMALL COUNTRY LIKE PANAMA, whose population only recently reached one million inhabitants, its shrimp fishery is of great economic significance. It constitutes about one-third of our exports, next only to bananas. During last year our shrimp exports were 8,250,000 pounds with a value of $6,127,000. An additional catch of about 600,000 pounds is sold locally. The industry is a source of employment for about 1,500 permanent workers and an additional 700 temporary workers. Ice suppliers, boat builders, parts suppliers, etc., derive benefits from this industry. The capital invested in boats, equipment, and plants is about $10,000,000.

Shrimp Resources

The shrimp fishery of Panama is based primarily on the following three species of white shrimp: *Penaeus occidentalis, Penaeus stylirostris* and *Penaeus vannamei;* of these, the first accounts for more than 75 per cent of the catch of these species, which total about 50 per cent of the total shrimp catch.

The pink grooved shrimp, *Penaeus brevirostris,* appears during the dry season (January-April) when the upwellings occur in the ocean. During these periods, which may last from a few days to two months, the pink shrimp is caught in great quantities as it concentrates near the coast. The total catch of this species fluctuates widely from year to year, and is apparently related to the appearance of cold water brought to the coast by the upwelling.

The sea bob, *Xiphopenaeus riveti,* although it receives a small price, is of importance as it forms a fair portion of the catch. There are other species that appear in the catch, like *Trachypenaeus byrdi, Trachypenaeus faoe,* and *Penaeus californiensis,* but because of the small quantities caught are of little importance.

At present, jumbo white shrimp brings the highest price, 94 cents per pound to the fisherman for under 10 count (i.e. fewer than 10 shrimp, heads off, to the pound). The price paid for the pinks last season was 75 cents per pound for the larger sizes, and the sea bob brings about one-third the price of the white shrimp.

Fishing Grounds

The white shrimp is usually fished near the coast at depths ranging from four to twelve fathoms. The principal fishing grounds are located in the Gulf of Panama, which is cup-shaped. Panama City is located at the center of the bay, and the shrimp fleet operates from there.

Most of the catch occurs in the Panama-Darien area in the east part of the Gulf. In this area, *P. occidentalis* usually accounts for more than ninety per cent of the white shrimp catch; most of the sea bob catch is also made here. In the Anton-Chame area, on the west side of the Gulf, *P. occidentalis* forms a much lesser proportion of the catch of white shrimp since the proportion of *P. vannamei* and *P. stylirostris* increases in this area as compared to the former.

The Darien area has muddy shallow water while the Chame area is deeper and has a sandy and muddy bottom. A few boats fish in Chiriqui and Gobernadora, where the species composition is similar to the Chame area.

It seems that *P. stylirostris* and *P. vannamei* are caught slightly deeper than *P. occidentalis*. The small shrimp, *X. riveti*, is caught on shallow, muddy bottoms, in water of low salinity, near river mouths. At certain times during the dry season, *P. brevirostris* is caught in depths less than thirty fathoms, even as shallow as fifteen fathoms.

Growth of the Fishery

The Panamanian shrimp fishery was started in 1950 when eight small trawlers began fishing; in 1952 there were fifty-three boats operating. During 1953, 1954 and 1955 the number of boats fishing were from eighty-two to eighty-nine. One of the reasons the boats did not increase during these years was because a law was passed prohibiting the importation of shrimp fishing boats. Before this, the boats fishing were used boats brought from the United States and Mexico.

During 1956 a shrimp boat construction industry was started which increased the number of boats to 122 in January of 1957, and to 200 this year. As a result of this fast expansion (from eighty-eight boats in early 1956 to 200 boats in 1958), the fishing intensity more than doubled. These were new, bigger boats, with more powerful motors and larger nets, whereas the earlier boats were smaller and older, with smaller nets and less powerful motors.

The increase in fishing intensity caused a decrease of nine per cent in the catch per unit of effort, of the white shrimp, in 1956. In the next year, when eighty boats were added to the fleet, the decrease in the catch per unit of effort was sixty per cent from the 1957 figure, and this year it has continued to drop.

The total catch of white shrimp, as compared to 1956, has been lower during this year and probably had a light drop in 1957. Statistical data will be completed shortly. During 1957, due to the highest catch of pink shrimp in the history of the fishery, the sharp decrease in the catch per unit of effort of the white shrimp was not felt until the end of that year. But in 1958 when the pink shrimp fishery failed, and the catch per unit of effort of the whites continued to drop, the industry has been in a critical situation. This year, the sea bob catch has been very good, but because of its low price, it has not prevented the present situation.

Some fifty boats have migrated to Brazil, Guatemala, Colombia, Honduras, Nicaragua and El Salvador. In 1957 with the high increase in the number of boats, a very low rainfall also occurred, and from January to April of 1958 a very poor upwelling took place. Since 1900 there were only three occasions where poor upwelling like this took place. The upwellings, which bring nutrients to the surface layers, are very important factors in the high productivity of the Gulf of Panama.

This year the rainfall is normal. If an average upwelling takes place, the pink shrimp catch should improve and the two factors would give clues as to the white shrimp situation.

WHITE SHRIMP

The white shrimp catch increases from May to August and then declines gradually to reach its lowest in December. During the dry season (January-

April), the white shrimp catch is low, and its abundance is dependent on the water temperatures associated with the upwelling in the gulf. In cold dry season years the white shrimp gets very scarce; there exists the possibility of a parallel to the coast and out of the gulf migration. During warm dry season years the white shrimp are more abundant.

There is evidence that the white shrimp spawns in the ocean floor in slightly deeper water than the commercial catches. *P. occidentalis* spawns throughout all the year, although there appears to be a peak from October to December.

P. occidentalis reaches the coast at an average size of 2.0 mm (carapace length), whereas *P. vannamei* and *P. stylirostris* arrive at an average size of 1.4 mm (carapace length). *P. occidentalis* spends its young stage at the edge of the tide in waters of high salinity (28 ‰ or more). In Panama there are very large tides ranging from 11½ to 18 feet.

P. vannamei and *P. stylirostris* enter with the tides and currents into interior brackish waters or river mouths, where they spend their juvenile phase. Those that enter the lagoons stay in the periphery of the lake, in the mangrove roots which furnish them with shade and protection. As they grow they move toward the center of the lake and after a fast growth return to the ocean. There they spend a short period in shallow water and then migrate to deeper water where they are available to the commercial catches. The young stages of *P. stylirostris* and *P. vannamei* occur mostly in salinities ranging from 5 to 15 per cent.

Growth rate experiments with *P. occidentalis* were carried on in the laboratory employing a method of Mr. Martin Burkenroad (Master, A., Graduation Thesis, Dinamica del Camaron Juvenil *P. occidentalis).* Live shrimp caught late in the afternoon were placed singly in gallon flasks containing water and mud from the same locality at which the shrimp were caught. It was assumed that the proportion of shrimp which molt during the first night after captivity represents the normal frequency of molting for those sizes at the place and time. The size of the carapace of the shrimp that molted was measured to compare it with the size of the molted carapace to get the per cent of linear growth. The molt frequency and the length increase at a given size gives the growth rate for this size.

Master calculated that it takes *P. occidentalis* about two months to grow from two to eleven mm (carapace length); then by applying the Waldorf Line and Equation, he estimated that a shrimp takes from nine to a maximum of fourteen months to reach a length of 45 mm, which is the average adult size for these species. At present, the laboratory is carrying on length frequency studies which will furnish a comparison to the above studies.

Pink Shrimp

The pink shrimp *P. brevirostris,* lives at depths greater than 30 fathoms, from April to November, where they seem to be so dispersed as to be unprofitable for commercial catches. During the dry season (January to April) the north wind blows often and with intensity, pushing the top water masses from the coast in the gulf offshore. This causes certain physical phenomena, studied by Fleming in 1940 and recently by the Inter-American Tropical Tuna Commission. The phenomena associated with the intensity of the winds are a drop in sea-level and water temperatures on the coast due to upwelled cold water, rich in nutrients which replaces the water masses blown offshore.

The average water temperatures from May to December are above 80°F.

They drop below this from January to April, reaching an average of about 74°F in March.

The pink shrimp migrates to depths less than thirty fathoms during this period. We have observed a relationship in the amount of the catches with the number of days of cold surface water below 76°F. When the surface temperature drops below this, the pink shrimp is found closer to shore and in big concentrations and catches as high as nine tons in three to four days have been reported. During the dry season of 1957 in which there were sixty days of cold water, the total catch of pink shrimp was near 3,000,000 pounds, and in 1958 when there were only eight days of cold water the catches did not reach 500,000 pounds.

Most of these shrimp caught in the dry season have ripe ovaries.

DISCUSSION

Shrimp Session

Discussion Leader: DONALD MCKEE

Discussion Panel: L. W. STRASBURGER, J. S. CARINHAS, JR., L. C. RINGHAVER, J. C. FERGUSON, F. FRITZ KOCZY

Marking Pink Shrimp (Penaeus duorarum) With Biological Stains—A Field Experiment

THOMAS J. COSTELLO

Q. Strasburger: There appear to be certain definite limitations to the use of dyes for marking shrimp. I wonder if you would give us a better evaluation of those limitations.

A. Costello: We have only three dyes that are cleared by the Food and Drug Administration, which limits the number of experiments we can run at one time. Our chemists now are working on a method of mixing dyes so that we may have as many as seven combinations and possibly many more, so that it would be possible, for instance, to use trypan red and fast green and trypan blue independently, and then mix them so that we can have a number of combinations. Since a shrimp's life cycle doesn't exceed fourteen months we would have a possibility of making 15 or 18 combinations in the same area without any possible confusion of data. By marking a group of shrimp in a narrow size range it is possible to get growth data which will apply to that whole group. The big advantage in staining is that we can stain approximately seven times as fast as we can tag shrimp.

Broadhead: You are talking in terms of how many more stained

(Comment): shrimp you can put out, but from some of our tuna work we can say that the rate of return is perhaps a good deal more important than ease of tagging. I feel certain your efficiency in returning the vital stains will be at least two or three times poorer than returns of tags. We find with tuna even with a very bright tag that we were losing about 50 per cent of them, and this despite the fact that maybe ten or twelve people handle these fish individually.

Q. Rae: Is there any evidence to show whether the colored shrimp are more, or less, likely to be taken by predators than are normal shrimp?

A. Costello: I don't know.

Q. Gunn: Does the Fish and Wildlife Service have a schedule for extension of the dyeing experiments?

A. Costello: Yes, we plan a staining program down the Keys with a second color, and a third color in the closed area in the Tortugas, and in May of next year a very large staining program in Clear Lake near Galveston. We may be able to answer a few basic questions so far as natural mortality rates are concerned by injecting a large group, maybe a hundred thousand stained shrimp, in the population there.

Fish Inspection in Canada

H. V. Dempsey

McKee (Comment): The shrimp industry has recognized the need for quality control and for standards on a voluntary basis. I hope we will some day have inspections and standards for seafood products as good as yours seem to be.

Q. Koczy: You said your inspection service cost $1,450,000. Have you estimated how much return you get?

A. Dempsey: One measure of the success of inspection would be an increase in the per capita consumption of fish, and another, the increased earnings to the fisherman.

As far as increased earnings to the fishermen are concerned, there has been an improvement in those ports where we have officers who grade the fish as it comes off the trawlers. Some of the major fishing companies in the Maritime Provinces are paying an incentive bonus of $14 a trip to the icer aboard the trawler, in order to encourage the landing of a higher proportion of Grade I fish.

We measure per capita consumption by the disappearance of fish stocks, balancing off what was exported and assuming the rest was consumed in Canada. There has been a slight

increase in consumption, but not as much as we hope will be shown in the next few years.

Q. Koczy: You talked about "subjective methods" of fish evaluation. What are these?

A. Dempsey: Our subjective measurements are substantially the appearance, odor, and the feel of the fish.

Q. Carinhas: Was this inspection self-imposed by the industry or was it government inspired?

A. Dempsey: It was asked for originally by the industry about eight or ten years ago.

Q. Carinhas: How is this service paid for?

A. Dempsey: By the Canadian taxpayer. There is no charge to the industry at all.

Q. McKee: Is inspection mandatory in all fish processing plants?

A. Dempsey: Certain types of inspections are mandatory: canned salmon, canned herring and all pickled fish, smoked fish, bloaters and similar products. At the present moment the inspection of fresh and frozen fish and the inspection of fresh fish processing plants is voluntary. The compulsion will come about, under our new program, through the insistence of the buyers—the chain stores and supermarkets for example—that the fish they purchase be of "Canada Inspected" grade and quality. In a sense we are acting as a referee between the buyer and the seller.

We are working towards national compulsory inspection of fish and fish processing plants, and the new "Canada Inspected" program which begins on the first of April will be a forerunner of compulsory inspection, within possibly the next two or three years.

Q. Ringhaver: You said that 65 per cent of the fish is exported. What are the principal nations you export fish to?

A. Dempsey: Of our fresh and frozen fish, 99 per cent of our exports go to the United States. Canned fish goes all over the world.

Q. Ringhaver: Do you inspect imported fish?

A. Dempsey: We have compulsory inspection of all imports of canned fish and shellfish coming into Canada. We have not yet had the time or the man power to make as close a check of packaged and frozen fish and shellfish as we would like.

Q. Strasburger: In regard specifically to canned shrimp which is imported in some quantity into Canada, it is my understanding that your most serious trouble with the product has been short weights. Do you mind outlining your method of weighing of a can of shrimp?

A. Dempsey: First of all, in examining any lot of canned shellfish, whether domestic or imported, we pay no attention to overweight

cans. Canned shrimp is first allowed to come to room temperature, around 68 to 75 degrees. The cans are opened and then allowed to drain from one to one and a half minutes, the shrimp are emptied onto a scale and weighed. If we find more than 25 per cent of a sample is over 1/10 of an ounce short weight we deem the entire lot to be short weight.

Q. Strasburger: Your method of determining the drained weight of the shrimp is at variance with the United States method set up in this country of draining the shrimp on a previously tared 8-mesh sieve. The sieve is then weighed and the exact weight of the shrimp is obtained.

Actual experimentations which I have carried out show that the United States' method will give from 14 to 28/100 of an ounce difference in one can between the two methods. Consequently, shrimp which are marketed in this country and which may be labeled as "five ounces" may be short weight if marked "five ounces" in Canada.

A. Dempsey: We have done a little work on this ourselves because we want to be practical and fair. We have come to the conclusion that, with our method of weight determination, any error is in favor of the canner. So far as the two methods are concerned it is hard to convince us that any difference between the two methods of measurement will account for short weights of over one-third of an ounce per can, which we often find.

Q. Hess: Mr. Strasburger, from the figures given the storage temperature in the United States' method of determining drained weight may be higher, and the length of draining longer, so theoretically one would expect more of the liquid to drain off and obtain therefore a relatively lower drained weight.

A. Strasburger: The amount of moisture which clings to the meshes of the sieve probably accounts for the differential.

Q. Saenz: Would you comment as to the value of putting the date of packing on a frozen food package so that the consumer may have an idea of the length of storage time of this product?

A. Dempsey: We are completely opposed to that. In our new inspection standards we provide for marking the date on containers or wrappers, but it is in code. Human nature being what it is, if the housewife is offered, for example, two packages of frozen halibut, one package marked May 15 and the other package marked May 30, she will buy the May 30 package. She is assuming that she is getting a fresher fish when, in fact, she may not be.

Q. Bullis: What percentage of your fish receiving plants have inspectors?

A. Dempsey: We have an inspector in every processing plant which will meet our standards. In some instances we have two inspectors, where plants are working double or triple shifts.

Sizes of Shrimp Caught and Distribution of Fishing Effort on the Tortugas Grounds

Andrew E. Jones and Edwin S. Iversen

Q. Ferguson: During the summer months with fifty or sixty trawlers on the grounds the relationship between the size of shrimp and depth was more pronounced than in the winter months with 500 or 600 boats on the grounds. Do you think that the large fleet of boats may have scattered the shrimp?

A. Jones: The extreme dispersal of small shrimp in September and October I would say was not caused by the boats. Apparently the shrimp spread quickly over the grounds at that time.

Progress in Biological Research on the Tortugas Shrimp

Edwin S. Iversen and C. P. Idyll

Q. Strasburger: In attempting to gather statistics on a purely voluntary basis as you have done, have you gotten cooperation from the industry or have you found certain individuals who don't want to give you the information you are seeking?

A. Iversen: Some people do not want to show their records and we have not yet gotten some records we would like to have had. The same thing has happened in the case of tagging. We know that some fishermen have thrown away tags. This is very unfortunate and hurts the fishermen themselves. Each returned tag is of great value to the program. On the whole, fortunately, we are getting good cooperation from the industry.

Q. Ramirez: We have a problem in Mexico. A certain type of gear is used to prevent the small shrimp from getting out of the lagoon to the sea. What effect would that have on the shrimp?

A. Iversen: If you block the exit of the young shrimp from the brackish water nursery grounds you take something away from the fisheries. How much you lose in large shrimp later depends on the rate of death of the shrimp in the meantime, balanced against the rate of growth. Before your question can be answered we must study these rates; this is essentially the basis of our research.

Q. Ferguson: Since the closed area on the Tortugas grounds has been enforced by the Florida Conservation Department we have noticed quite an increase in our catches. I would like to know if the research indicates whether these are cause and effect.

A. Iversen: We are unable with our present information to judge whether this year's improved catches were produced by the closed area. There is a fifty-fifty chance that they will be better in any one year compared with the previous year. We do not yet have the scientific information to base a decision on.

The Territorial Waters Dispute and the Shrimp Industry

William R. Neblett

Q. Ringhaver: How is the Continental Shelf determined?

A. Neblett: The legal definition of the Continental Shelf is the submerged land out to 200 meters depth, or to the limits of exploitability.

A Survey of the Shrimp Fishery of Panama

Juan L. Obarrio

Q. Galtsoff: It appears that the abundance of shrimp in Panama is correlated with the degree of ocean upwelling. Have you any theories as to how the upwelling affects the life of shrimp or other organisms in the Gulf of Panama?

A. Obarrio: Whenever the number of cold days is higher, the catch of shrimp is higher. This upwelling is caused by a north wind that pushes the waters up the coast and causes the lowering of the sea level, so that offshore water from the bottom, which is colder, comes to the coast to replace this water that was blown offshore. This appears to bring the shrimp within range of the boats.

TUESDAY—NOVEMBER 18

Chairman—STANLEY W. LETSON, *President, Maine Marine Products, Portland, Maine*

The New Industrial Fisheries Industry of the North Central Gulf of Mexico Area

TRAVIS D. LOVE AND M. H. THOMPSON

Bureau of Commercial Fisheries, U. S. Fish and Wildlife Service
Pascagoula, Mississippi

THE TITLE "INDUSTRIAL FISHERIES," as used in this paper, does not include menhaden. For many years it has been customary to speak of the small non-food fish discarded from shrimp trawling catches as "trash fish," and with the establishment of an entirely new commercial enterprise based on the use of these small non-food species, the term "trash fish" persisted. Now that this industry has attained some financial and commercial stature, persons concerned feel that we should designate it as "the industrial fish industry."

This industrial fish industry is based on the catch, mostly by former shrimp boats of the Pascagoula-Biloxi area, of the following species, in order of importance:

1. Croakers, *Micropogon undulatus*
2. Silver eels (cutlass fish), *Trichiurus lepturus*
3. Anchovies, *Anchoa hepsetus*
4. Spot, *Leiostomus xanthurus*
5. Razor belly herring, *Harengula pensacolae*
6. Round herring, *Etrumeus teres*
7. White trout (lesser weakfish), *Cynoscion sp.*

In addition, the following species are often taken in the nets:

1. Thread herring, *Opisthonema oglinum*
2. Silversides, *Menidia sp.*
3. Butterfish, *Poronotus triacanthus*
4. Shad, *Pomolobus chrysochloris*
5. Sea robin, *Prionotus sp.*
6. Sea bass, *Diplectrum sp.*
7. Ground mullet, *Menticirrhus americanus*
8. Star drum, *Stellifer lanceolaotus*
9. Menhaden, *Brevoortia patronus*

With the establishment of the Technology Laboratory at Pascagoula in June, 1957, there was already in existence an industrial fish industry in the form of two large pet food plants, established during 1952-53, and producing thousands of cases daily of a pet food containing approximately seventy to seventy-five per cent fish. Two additional plants had more recently made pilot runs and were attempting to secure contracts to pack for national brands. This pet food industry was able to pay approximately $35 per ton for these industrial fish, but limited the trawlers on the amount of fish to be delivered each week. The two operating plants, both located in the immediate Pascagoula area, gave employ-

ment to several hundred boatmen, plant workers, and workers in supporting industries, such as ice plants and motor repair shops.

During the spring of 1958 there was a sudden spurt of interest in these industrial fish as a source of protein in animal foods. One of the pet food pilot plant operators secured a large production contract for thousands of cases of pet food per week with a company marketing a well-known national brand. The other pilot plant operator obtained contracts from brokers which would enable him to operate full time. Thus, there are four large scale pet food plants operating at present.

Some additional usage of these fish has been made in the fur farming industry, especially for the feeding of mink. Here, certain technological problems arise. Some species contain appreciable amounts of an enzyme, thiaminase, which inhibits the absorption of, or prevents utilization of, thiamine present in the diet. (Lee, Nilson and Clegg, 1955.) This enzyme produces, rather quickly, a temporary sterility in mink and other fur-bearing animals. In addition, continued feeding of these thiaminase-positive species of fish will produce lusterless fur, lack of appetite, and general malaise due to lack of the vitamin thiamine in the daily diet. Ultimately, the animal may succumb due to onset of Chaste's paralysis. The Bureau of Commercial Fisheries Technological Laboratories at Boston, Seattle, and College Park have made enough experimental quantitative analyses to give an indication as to which species contains this enzyme in detrimental amounts. The Pascagoula Laboratory may be able to further amplify the available information on this subject sometime in 1959. Thiaminase is not a problem in the pet food industry, since the enzyme is destroyed by the high temperatures of processing the canned product.

The greatest potential for growth in this industry is being explored in a new direction, that of fish protein for the poultry broiler industry. It may be now commercially feasible to produce fish meal from these industrial fish with no attempt to extract oil. The present price of fish meal for poultry feed has stimulated several individuals to apply their technological knowledge to a more economical production of fish meal. We have two plants in production in the Pascagoula area which use a continuous-flow type of dehydration of industrial fish to produce a dried meal acceptable to the local broiler industry. Four additional plants are either in the blueprint or construction stage, and are expected to be in production on fish meal by 1959.

In addition to these possible applications of industrial fish, the Fishery Technology Laboratory at Pascagoula has recently received several inquiries concerning other forms of protein from fish available for human and animal food. One firm has expressed an interest in a method for the extraction of fish flour for human consumption. Another firm is interested in the production of "fish solubles" from these industrial fish species.

Last March the Technological Laboratory began work on a project to develop data on the quantitative chemical analysis of these industrial fish in order to help the growing industry to control its output more closely from season to season. To further our knowledge of species variability, samples of industrial fish are being obtained by our chemists from three or four boats each week. Analyses are made on the lot as it comes from the boat, for fat, moisture, protein, and ash. Pet food producers had previously noted that seasonal variations occur in composition and that the constituents may vary from different areas. By periodic sampling of major areas, we will enable the industry to forecast

the oil, protein, moisture, and ash content of a boatload of fish, from a given area, at a given date. In addition to the analysis of the gross load, we have a biologist, from the Gulf Exploratory Group, sort out by species the fish of a five pound lot from a boat, and proximate analyses are made on each species. From these data we can estimate more closely the possible oil and meal yield of a mixed load by estimating the percentages of each species present. Table 1 gives a cross section of the percentage of various species present and the analytical results of the mixed loads, determined by chemists in the Pascagoula Laboratory. Tables 2-5 show the results of analyses on the more common species used in the industrial fisheries during recent seasons. (Thompson, 1958.)

Table 6 demonstrates the species having the greatest variations of fat and moisture from season to season. The following general observations may be made from these analyses:

1. Oil Content
   a. Largest variability by species was that of spot, *Leiostomus xanthurus,* with 5.5 per cent oil for winter and 16.5 per cent oil for summer.
   b. Most species will fall in the 2 to 6 per cent range of variability in oil content from winter to summer.
2. Protein Content
   a. Does not vary greatly within the same species from season to season.
   b. Catches of certain species from unmixed schools will show marked seasonal variations in composition between the species, *e.g.,* small butterfish in May showed 14 per cent protein, while spring shad had 19.5 per cent protein.
3. Moisture Content
   a. Moisture usually varies inversely with oil values; *e.g.,* winter spot, 76.5 per cent moisture and 5.5 per cent oil; summer spot, 64 per cent moisture and 16.5 per cent oil.
   b. Moisture ranges for different species may be economically significant with 81 per cent for immature spring butterfish and only 64 per cent spring spot.
   c. Most species fall in the 70 to 77 per cent range with mixed loads at about 73 per cent.
4. Ash Content
   a. Depends on the size of the fish for most species.
   b. Extreme ranges show 2.3 per cent for summer cutlass fish and 8.3 per cent for large winter silversides.
   c. Most species and mixed loads will average 3 to 4.5 per cent ash.

The value of technological studies in this industry was pointed up recently by the sudden appearance in local trawls of huge catches of small immature butterfish, *Poronotus triacanthus.* These fish, containing proportionately larger amounts of skin, gave a darker, more gelatinous petfood than usual. Since the moisture content of these fish was approximately 81 per cent, rather than the 73 per cent of the usual mixed load, the canned product contained more than the label declaration of water. Analytical data secured by the laboratory at that time was quickly made available to the entire industry with a warning that loads of 100 per cent small butterfish might contain too much moisture for the usual canning procedures. Dry meals, such as soy bean meal, could be used to adjust

the moisture of the canned product and maintain normal food values.

At the present time, we are analyzing dry fish meals from loads of known history to provide data for estimating meal yields. It is easy to see that a load of butterfish with 81 per cent moisture might not warrant the same price per ton for meal as would a mixed species load at 73 per cent moisture.

As to the future potential of this industry, and the estimated effects of this fishery on supply, we must quote the biologists, and we feel that theirs is but an educated guess. It was estimated by U. S. Fish and Wildlife Service biologists at the 1950 meeting of the Gulf States Marine Fisheries Commission that 500 million pounds of "trash fish" were picked out and discarded annually by shrimp trawlers alone. It is worth noting at this point that, although sport fishermen complain bitterly about this industry's harmful effect on the game and food fish such as red fish, speckled trout, sheephead, and the like, rarely, if ever, can we find even one member of these species in a trawl of this industry. One of the few exceptions is white trout, *Cynoscion sp.,* occasionally found scattered through a load. Our biologists estimate that the white trout never amount to 2 per cent of any load, and most often is entirely missing. At rare intervals, small flounder, snapper, grunt, and mullet will appear in the mixed loads. If a study of the effects of this fishery on the marine biology of the area could be initiated now, we would have a more firm basis for promulgation of future regulations to prevent overfishing. Data gathered now will form the base from which to judge the effects of both fishing and other harmful influences in the future. The data now being gathered by the chemists at Pascagoula, while actually of technological nature, will reflect any wide variations of biological nature by changes in the percentages of the various species encountered in sampling from the trawl boats.

The extended area from the east coast of Florida to Mexico, including the Caribbean, apparently contains huge amounts of these small non-food fish. Since they are apparently caught during the second and third year of life and, since only a relatively small area of the Gulf is now fished, there should be no diminution of supply forecast in the foreseeable future. Also, these industrial fish, once discarded or avoided by the shrimp fleet, are now being utilized to provide financial returns along the north central Gulf.

Thus, in future years, as the world's population outgrows the ability of the land to produce its food, interested fishermen, plant owners, and allied industries will have a foothold in the world's greatest source of food for human and animal use, the ocean.

LITERATURE CITED

Lee, Charles F., Hugo W. Nilson, and William Clegg

1955. Technical Note No. 31—Weight range, proximate composition, and thiaminase content of fish taken in shallow-water trawling in northern Gulf of Mexico. U. S. Fish and Wildlife Service, Comm. Fish. Rev., 17 (3): 21-23 (Separate No. 396)

Thompson, Mary H.

1958. Proximate composition of Gulf of Mexico industrial fish. Part 1. — Winter and spring studies (1958). (In preparation.)

1958. Proximate composition of Gulf of Mexico industrial fish. Part 2 — Summer studies (1958). (In preparation.)

TABLE 1

THE COMPOSITION OF INDUSTRIAL FISH OF THE NORTH CENTRAL GULF, 1958

Sample	Date	Type of Catch	Location	% Moisture	% Protein	% Fat	% Ash
1	3/24	85% Thread fin 15% mixed	Chandeleur Island	77.6	14.7	4.7	2.95
2	4/24	75% Croakers 20% Silver eels 5% Spots & Flatfish	Between Grand Isle and Ship Shoal	78.2	14.9	4.8	2.49
2a	4/24	5% Spots & Flatfish	Between Grand Isle and Ship Shoal	77.7	14.9	4.5	2.87
3	4/25	75% Croakers 20% Silver eels 5% Flatfish	Between Grand Isle and Ship Shoal	75.1	15.9	5.2	3.45
4	4/28	100% Menhaden	North Gulf	67.7	13.6	14.1	2.10
5	5/6	98% Croakers 2% White trout	Off Mouth of Mississippi River	75.9	18.4	4.6	3.61
6	5/12	100% Butterfish	Chandeleur Island	80.7	14.4	2.3	3.06
7	5/17	95% Croakers & Spots 5% Silver eels	Mississippi River	79.2	14.5	6.9	2.76
8	5/18	50% Silver eels 50% Mixed Croaker, Spots, Herring and Flatfish	Gulfport Channel	79.1	14.5	3.4	4.07
9	5/27	Even mixture of Silver eels, White trout, Croaker, Spots, Mackerel minnow (anchovies) Razor bellies	Mississippi River	73.4	15.3	6.5	4.28
10	6/17	50% Croakers 50% Eels, Anchovies, Thread herring	Breton Island	78.5	13.7	3.7	3.89
11	6/19	100% Star drum	Horn Island	76.3	15.0	3.8	4.11
12	6/25	50% Star drum 50% Mixed Silver eels, Razor bellies and White trout	Horn Island	78.7	14.5	4.4	3.27

TABLE 2

COMMON INDUSTRIAL FISH ANALYSIS — WINTER 1958

Fish	Date	Location	No. of* Determ.	Type Meas.	Length in cm Rge.	Length in cm Ave.	Weights in gm Rge.	Weights in gm Ave.	% Moisture Rge.	% Moisture Ave.	% Protein Rge.	% Protein Ave.	% Fat Rge.	% Fat Ave.	% Ash Rge.	% Ash Ave.
Silver eels (Cutlass fish) *Trichiurus*		Miss.			36.7		25.4		75.0		17.9		4.1		2.63	
lepturus	Feb.	Sound	4 (4)	Overall	45.8	42.8	48.6	37.6	75.8	75.4	18.2	18.1	4.4	4.3	3.23	2.96
Spots		Miss.			18.8		81.4		76.4		13.8				3.96	
Leiostomus xanthurus	Feb.	Sound	2 (2)	Forktail	20.2	19.5	90.2	85.8	76.5	76.5	14.2	14.1	5.5	5.5	4.21	4.09
Thread herring		Miss.			13.4		36.8		68.4		18.5		7.8		2.57	
Opisthonema oglinum	Feb.	Sound	4 (4)	Forktail	15.4	14.3	52.8	43.8	70.1	69.3	19.2	18.9	8.3	8.1	3.66	3.24
Anchovies *Anchoa sp.*	Feb.	Miss.	4		5.0		1.4		75.6		16.3		3.3		3.33	
		Sound	(72-93)	Forktail	7.0	6.0	4.0	2.5	76.1	75.9	16.7	16.4	3.9	3.5	3.53	3.45
Silver sides		Miss.	4		7.5		4.4		67.1		17.2		5.6		7.74	
Menidia sp.	Feb.	Sound	(26-28)	Forktail	9.8	8.7	9.2	6.3	68.1	67.5	17.6	17.4	6.1	5.9	8.84	8.23
Round herring		Miss.			14.5		35.5		73.6		18.3		2.2		3.39	
Etrumeus teres	Feb.	Sound	4 (3)	Forktail	17.1	15.6	59.0	47.0	74.1	73.8	19.3	18.9	2.7	2.5	4.09	3.82
Butterfish		Miss.			12.5		53.5		77.1		14.6		1.6		2.56	
Poronotus triacanthus	Feb.	Sound	6 (2)	Forktail	16.8	14.7	100.	75.4	80.3	79.3	16.2	15.1	3.4	2.2	3.26	2.82
Croaker		Miss.			18.6		61.0		75.9		14.5		1.6		4.59	
Micropogon undulatus	Feb.	Sound	6 (2)	Forktail	21.1	19.8	116.	77.2	78.5	77.2	15.8	15.2	2.8	2.2	6.42	5.98
Razor bellies		Miss.			13.1		21.0		66.2		18.2		6.5		6.1	
Harengula pensacolae	Feb.	Sound	6 (6)	Overall	15.9	35.4	42.5	14.8	68.0	67.1	19.7	18.9	9.3	7.7	8.1	7.1
Anchovies		Miss.	4		10.9		13.3		75.3		16.3		2.5		3.44	
Anchoa hepsetus	Feb.	Sound	(12-13)	Forktail	12.9	11.7	25.1	19.0	76.3	75.7	17.9	17.3	2.8	2.6	3.76	3.53

NOTES: Numbers in parentheses indicate number of fish in each sample.
All samples frozen on board vessel.

TABLE 3

COMMON INDUSTRIAL FISH ANALYSIS — SPRING 1958

Fish	Date	Location	No. of* Determ.	Type Meas.	Length in cm Rge.	Length in cm Ave.	Weights in gm Rge.	Weights in gm Ave.	% Moisture Rge.	% Moisture Ave.	% Protein Rge.	% Protein Ave.	% Fat Rge.	% Fat Ave.	% Ash Rge.	% Ash Ave.
Spots		Grand			19.0		109.8		63.3		15.5		16.0		3.27	
Leiostomus xanthurus	May	Isle	4 (2)	Forktail	21.0	20.0	143.5	125.	64.4	63.9	16.2	15.8	16.8	16.5	4.17	3.74
Shad		North			18.6		82.6		72.7		19.4		2.0		2.01	
Pomolobus chrysochloris	Mar	Fla.	4 (2)	Forktail	21.7	20.0	128.2	106.7	74.9	73.6	19.6	19.6	4.4	3.2	3.23	2.52
Butterfish		Chandeleur			5.8		3.8		80.5		14.1		2.1		2.85	
Poronotus triacanthus	May	Snd.	4(37-41)	Forktail	9.7	6.7	16.3	6.0	80.9	80.7	15.0	14.4	2.5	2.3	3.31	3.06
Anchovies		North			9.5		10.6		75.0		16.9		2.9		3.21	
Anchoa hepsetus	Mar	Fla.	4(13-14)	Forktail	11.7	10.8	20.6	15.	75.9	75.6	17.1	17.0	3.2	3.0	3.43	3.36
Thread herring		North			17.0		77.2		69.9				4.8		4.46	
Opisthonema oglinum	Mar	Fla.	4 (2)	Forktail	19.6	18.3	115.5	95.6	70.8	70.4	19.4	19.4	5.4	5.0	4.94	4.59

*NOTE: Numbers in parentheses indicate number of fish in each sample.

All samples with exception of the iced spots and butterfish were frozen on board vessel.

TABLE 4

Common Industrial Fish Analysis — Summer 1958

Species	Date	Location	No. of* Determ.	Type Meas.	Length in cm Rge.	Length in cm Ave.	Weights in gm Rge.	Weights in gm Ave.	% Moisture Rge.	% Moisture Ave.	% Protein Rge.	% Protein Ave.	% Fat Rge.	% Fat Ave.	% Ash Rge.	% Ash Ave.
Silver eels (Cutlass fish) *Trichiurus lepturus*	June	Grand Isle	4 (3)	Overall	38.3-54.7	48.5	26.4-99.8	62.5	77.2-78.8	77.9	15.9-16.6	16.3	2.3-2.8	2.6	1.90-2.91	2.26
Spots *Leiostomus xanthurus*	July	Cat Island	4 (2)	Forktail	17.7-19.5	18.5	84.7-112.3	98.3	67.1-70.4	68.1	14.8-15.6	15.2	11.6-13.7	12.9	2.85-3.78	3.39
Thread herring *Opisthonema oglinum*	Aug.	Cat Island	4 (1-2)	Forktail	18.1-18.8	18.5	89.0-109.9	100.1	73.4-75.2	74.4	18.3-18.8	18.6	3.2-3.9	3.5	2.76-4.19	3.27
Butterfish *Poronotus triacanthus*	June	Grand Isle	4 (2-4)	Forktail	9.7-15.0	11.6	19.0-90.9	42.2	74.2-78.5	76.0	15.0-15.9	15.6	4.9-7.4	6.2	1.49-3.12	2.36
Croaker *Micropogon undulatus*	June	Grand Isle	4 (2)	Overall	17.9-21.0	19.4	65.6-111.3	88.1	67.1-73.0	69.9	15.6-16.3	15.9	6.3-10.0	8.6	4.29-5.60	4.85
Croaker *Micropogon undulatus*	July	Cat Island	4 (2)	Overall	20.2-26.0	22.2	81.4-181.7	118.5	75.0-77.8	76.0	16.4-16.9	16.7	2.8-4.5	3.6	2.37-3.41	3.05
Razor bellies *Harengula pensacolae*	June	Breton Island	4 (4)	Forktail	11.0-15.0	12.9	22.8-60.1	37.5	70.9-73.4	71.8	17.1-18.9	18.4	4.4-5.4	5.0	3.64-5.61	4.81
Anchovies *Anchoa hepsetus*	June	Breton Island	4(14-16)	Forktail	10.1-11.8	10.8	8.4-19.4	12.3	76.9-77.6	77.3	17.1-17.3	17.2	2.2-3.3	2.6	3.20-3.44	3.29
Star drum *Stellifer lanceolatus*	June	Horn Island	4(9-10)	Overall	10.9-13.9	12.5	10.8-29.4	20.2	75.1-76.9	76.3	14.4-15.2	15.0	3.4-4.0	3.8	3.89-4.28	4.11

*Note: Numbers in parentheses indicate number of fish in each sample.

TABLE 5

COMMON INDUSTRIAL FISH ANALYSIS — SUMMER 1958

Species	Date	Location	No. of* Determ.	Type Meas.	Length in cm Rge.	Length in cm Ave.	Weights in gm Rge.	Weights in gm Ave.	% Moisture Rge.	% Moisture Ave.	% Protein Rge.	% Protein Ave.	% Fat Rge.	% Fat Ave.	% Ash Rge.	% Ash Ave.
Harvest fish		Cat			13.0-		83.9-		70.4-		16.1-		4.8-		2.08-	
Peprilis sp.	July	Island	4 (1-2)	Forktail	16.2	14.8	129.9	111.2	76.9	73.0	16.8	16.4	9.0	7.5	2.69	2.31
Threadfin		Cat			10.4-		15.9-		76.2-		16.9-		1.6-		3.52-	
Polynemus sp.	July	Island	4 (8)	Forktail	12.2	11.3	27.9	20.7	77.3	76.6	17.6	17.3	2.1	1.8	4.15	3.98
Bumper																
Chloroscombrus		Cat			15.4-		50.7-		70.3-		18.6-		4.8-		3.42-	
chrysurus	July	Island	4 (2)	Forktail	17.2	16.5	71.1	61.0	73.0	71.3	18.9	18.7	6.9	6.0	5.15	4.22
Hardheads		Grand			22.1-		149.8-		70.5-		16.6-		6.1-		2.70-	
Galeichthys felis	June	Isle	4 (1)	Forktail	24.2	23.3	204.2	182.6	72.1	71.0	17.5	17.0	7.2	6.7	5.06	4.14
White trout		Cat			17.6-		55.1-		73.1-		17.0-		3.3-		2.56-	
Cynoscion sp.	July	Island	4 (1-2)	Overall	29.9	22.2	128.0	87.8	76.5	74.3	18.1	17.5	6.3	5.0	3.76	3.09
Menhaden		Chandeleur			15.9-		82.2-		60.5-		14.1-		13.1-		3.30-	
Brevoortia sp.	Aug.	Island	4 (1-2)	Forktail	19.5	17.4	161.4	110.3	66.8	63.3	16.1	14.9	20.5	17.8	4.08	3.66

*NOTE: Numbers in parantheses indicate number of fish in each sample.

TABLE 6

SEASONAL CHANGES IN MOISTURE AND FAT CONTENT

Species	Moisture Change Winter to Spring	Moisture Change Spring to Summer	Moisture Change Winter to Summer	Fat Change Winter to Spring	Fat Change Spring to Summer	Fat Change Wint. to Sum.
Spots *Leiostomus xanthurus*	-12.6%	+4.2%	-8.4%	+11.0%	-3.6%	+7.4%
Butterfish *Poronotus triacanthus*	+1.4	-4.7	-3.3	+0.1	+3.9	+4.0
Anchovies *Anchoa hepsetus*	-0.1	+1.7	+1.6	+0.4	-0.4	0.0
Thread Herring *Opisthonema oglinum*	+1.1	+4.0	+5.1	-3.1	-1.5	-4.6
Silver eels (Cutlass fish) *Trichiurus lepturus*	—	—	+2.5	—	—	-1.7
Croaker *Micropogon undulatus*	-7.3*	+6.1*	-1.2*	+6.4*	-5.0*	+1.4*
Razor Bellies *Harengula pensacolae*	—	—	+4.7	—	—	-2.7

*Time of Catch: Winter to Early Summer to Late Summer, 1958

Recent Accomplishments in the Fish Oil Utilization Program

Jack Holston
Chief, Branch of Technology,
Bureau of Commercial Fsheries, Washington, D. C.

The Bureau of Commercial Fisheries, with the advice and assistance of the members of the Industrial Products Division of the National Fisheries Institute, four years ago undertook to support a full-scale program of research into the chemistry and technology of domestic fish body oils. The objectives of this program were to supply such basic information as would be necessary for development of new markets for these oils, and to support applied research in possible uses of fish oils which looked promising. These uses, if successfully developed, would give the industry additional market outlets for its product, pending completion of the possibly more rewarding basic research studies.

Such an extensive research program requires justification. Approximately one half of the total poundage of fish annually landed in the United States is destined for industrial usage. Such an important phase of the fishing industry merits research assistance by the Bureau. Further, the foresight of the Bureau and of the industry in supporting research designed to lessen our dependence on a single major outlet has recently been vindicated. The recent formation of the European Common Market may adversely affect our large export of fish oils destined for use in margarine manufacture. Finally, we should point out that any knowledge gained through this program of fish oil oxidation mechanisms would be of inestimable benefit to all phases of the fishing industry. The familiar "rusting" and yellowing of frozen edible fishery products, for example, is just another form of *in situ* oxidation of fish body oils.

The utilization research program is in its fourth year and has been carried out on a national basis at both Bureau laboratories and, by contract, at several research institutions. Foremost among the latter have been the Hormel Institute and the University of California. The basic research aspects of the investigation have been studied from many angles. We are investigating the mechanisms involved in enzymatic and in autoxidation of the oils to find the weak spots where such deterioration takes place and, more important, to determine what we can do to strengthen them. We are taking apart, molecule by molecule, the very complex mixtures that comprise fish oils to study and characterize each molecule through its physical and chemical constants. We are studying, with a view to prevention of their formation, the chemical nature of the volatile degradation products that appear to give fish oil its rather penetrating odor. We are investigating the chemical reactivities of the fatty acids derived from fish oils to determine whether some unique, commercally-desirable compounds may be formed through reactions at the carboxyl groups or at any of the many points of chemical bond unsaturation on the fatty acid molecule. We are testing the fatty acids for their nutritional value, for possible growth promoting effects, for possible physiological value in regard to the so-called essential fatty acid syndrome, and for possible beneficial effects on the serum cholesterol levels in blood. Our applied research efforts have been in the following fields, (1) possible inclusion of fish oils in animal rations as an energy source, (2) possible utilization of fish oils in the preparation of leather, (3) possible utilization of

fish oils in ore-flotation, and (4) possible utilization of fish oils in insecticides.

The present paper is a review of findings to date. The majority of the work mentioned has not been published and while we anticipate no major change in the findings, they are not final.

Basic Research

Characterization of Fish Oil Fatty Acids

Fish body oils are largely composed of triglycerides. These are molecules composed of three fatty acids linked together by a glycerine molecule. Our first step has been to break down these triglycerides, to release the fatty acids. We then intend to separate out each different fatty acid in chemically pure form for characterization and study. This has been an enormously difficult job, and has through the years discouraged research into fish oil fatty acids. The acids are easily destroyed or altered during fractionation by distillation or other known methods of separation. To complicate the job still more, an acid, in addition to differing in molecular length, may differ also in numbers and placement of points of chemical unsaturation on the molecule. To date, after much effort, we have separated in chemically pure form only two fatty acids. They are the eicosapentaenoic and 4, 7, 10, 13, 16, 19-docosahexaenoic acids. We have these acids under study. We know their characteristic infra-red, and ultra-violet spectra, their boiling and freezing points, and other physical and chemical constants. More important, however, we now have what may be a reproducible, essentially non-destructive, laboratory technique for the isolation of individual fatty acids.

If this is confirmed by work now in progress, we can look forward soon to achieving a full and complete characterization of the fatty acids commonly found in fish oils.

Oxidation of Fish Oils

The Bureau's studies on the problem of oxidation of fish oils, both extracted oils and oils remaining in the fish flesh, have been undertaken from two approaches. The first approach, that of catalytically or enzymatically induced oxidation, has yielded much useful information. We now know, for example, that the hematin in fish meal catalyzes deterioration of the residual oil in the meal and that a similar reaction is involved in the discoloration of canned tuna. We have, in the laboratory, developed techniques to guard against the occurrence of such oxidative deterioration and are now field-testing these techniques.

Our studies in enzymatic oxidation of fish oils indicate these oils to be the main energy source used to spark the metabolic processes of the live fish. No essential differences in form or rate of enzymatic breakdown of mammalian and fish fatty acids have been found. The well-known Beta oxidation and tricarboxyllic acid cycles processes of intermediary metabolism are operative in fishes. These findings are of fundamental importance for an adequate understanding of fish oil deterioration. In this regard, our scientists have compiled and annotated the first authoritative review of the world's literature on intermediary metabolism in fishes. We expect to publish this valuable work in the near future.

The second approach to the study of fish oil oxidation has been primarily through a study of the effects of antioxidants. Much light has been thrown on this controversial subject. The investigations strongly suggest that, to be successful, each antioxidant should be tailored for each specific use to which it is put. The presence of certain natural components in the oil, for example, monoglycerides, tocopherols, free fatty acids, certain organic amines or amino acids, or of metallic impurities can markedly affect, for better or for worse, the efficacy of any particular antioxidant. There is a very strong evidence that a compound which acts as a synergist to one antioxidant may well act as an antagonist to another antioxidant. All of these clues and many others not mentioned here are being fitted into the jigsaw puzzle of autoxidation which we hope to complete. A technique has been developed to detect rapidly and essentially simultaneously metallic impurities in fish oils at levels as low as two to four parts per million parts of oil. Such metallic impurities catalyze the breakdown of the oils. Mixtures of such impurities as cobalt tallate, lead octoate, copper naphthenate, and manganese octoate at levels of four ppm have been detected and characterized in a single sample of oil. A system of column-refinement of the oil to remove such impurities has been developed for use in the laboratory.

Nutritional Value of Fish Oils

The total omission of fats from the diet of humans or animals results in a series of physiological disturbances known, in general, as the "essential fatty acid syndrome." These disturbances may include cessation of growth, breakdown of skin tissue, skin discoloration, etc. To these effects, there has been added the depression of blood-serum cholesterol levels, which are of interest because of possible implication in atherosclerosis therapy.

Inclusion of certain unsaturated fatty acids in the diet dramatically corrects these conditions. Investigations in this field with fatty acids derived from fish oils indicate that a major reassessment of the "essential" fatty acids activity theory may be necessary. Our researchers at Hormel Institute have reported that while fish oil fatty acids do not correct tissue breakdown conditions nor skin discoloration they do promote resumption of growth and do markedly depress blood-serum cholesterol levels. While tissue breakdown and skin discoloration are indices of extreme fatty acid dietary deficiencies, such cases are very rare in the United States. On the other hand, our serum-cholesterol levels, because of United States dietary habits, are sometimes quite high. If the present theory that cholesterol deposits are implicated in atherosclerosis is found to be valid, there is a strong possibility that the use of fish oil derivatives may become of therapeutic interest.

Applied Research

Use of Fish Oils in Ore-Flotation

Crushed metallic ores are customarily concentrated and enriched by exploiting the different "wetting" capacities of water and of oleic acid. Metals immersed in an oleic acid-water bath are preferentially wetted by the acid. The metals remain suspended in the acid while the useless gangue, wetted by the water, sinks to the bottom of the flotation tank. The acid, carrying with it the enriched metallic particles, is removed for further processing of the particles. Our contractors report that fish oil fractions, with iodine values of between 70

and 140 are excellent flotation agents fully equal to oleic acid now used. A large potential market exists if suitable fractionation of fish oil on an economically competitive basis can be developed.

Later work, undertaken on magnetically enriched low grade Mesabi taconite ores, indicated that the more highly unsaturated fatty acids (IV greater than 140) were extremely effective flotation agents in highly alkaline flotation baths. Under these conditions, acids "wet" and suspend the gangue while the metals sink. Using the combination of magnetic enrichment followed by alkaline flotation, silicate impurities in the ore concentrate have been reduced to as low as two per cent by weight. This "inverted" flotation process is less critically dependent upon the *ph* of the bath, possesses a wider tolerance to the presence of crushed ore "slimes," and owing to the absence of adsorbed fatty acids on the iron oxide, the concentrates so produced are more amenable to the pelleting process used with taconite ores. We will request a public service patent for this newly developed process.

Use of Fish Oils in Leather

Fish body oils have been used only to a very limited extent in leather processing because of a pronounced tendency toward combustion or charring during sulfonation. Also, leather prepared from such oils sometimes was alleged to exhibit "spew" when aged. Our researchers, in the course of a very detailed and authoritative research into the characteristics of fish oil containing leather, both aged and fresh, developed a novel adaptation of the sulfonation process which effectively prevented combustion of the oils. An exhaustive, comparative statistical analysis of controlled routinely prepared leathers and fish body oil containing leathers indicated that no significant differences exist. Both leathers were judged to be excellent.

Since domestic fish body oils are, at present, cheaper than raw oils, there would appear to exist a large potential market for fish body oils in the leather industry. The oil processors, wishing to develop this market, however, must accept the fact that education of the leather manufacturer is necessary and that further unforeseen developmental research may be necessary. A public service patent is being obtained by the Bureau for the newly developed sulfonation procedure. The studies indicated that the use of chemically-saturated oils produced soft leathers while the more unsaturated fish oils produced firm leathers. Again, if an economical system of fractionation of fish oils on the basis of chemical unsaturation can be developed, there exists a strong potential market for fish oils in the manufacture of both soft and firm leathers.

In essence, all of our work has indicated that future studies should be concentrated, to a large extent, on the autoxidation and odor problem. This we feel is the key-log in the log-jam which has held up the commercial exploitation of fish oils. To this end, we have planned to hold a two-day symposium on autoxidation and fish oil odor studies at our Seattle Laboratory during March 1959. We are asking that all technical persons, who are interested in oil utilization, attend the symposium and to bring with them notes and their observations as to the causes and cures of autoxidation and odor-causing deterioration.

We are convinced that industry should now undertake careful studies into the feasibility of further processing of their fish oils into three or more fractions as a function of degree of unsaturation. Such fractions will, undoubtedly, be the

first form of exploitation of fish oils. We cannot undertake this work without unduly dissipating our research effort. We feel it to be more fitting for us to continue our emphasis on the more basic research. We will, of course, do all in our power to assist the industry in establishing commercially feasible fractionation processes.

Exploratory Fishing For Sardine-Like Fishes in the Gulf of Mexico

JOHN R. THOMPSON
U. S. Fish and Wildlife Service
Pascagoula, Mississippi

Introduction

It is convenient, for present purposes, to recognize two fundamental regions in the marine environment, namely, the benthic or bottom region, and the pelagic region comprising everything above the bottom. Each division contains its own unique fauna and, as far as fisheries are concerned, poses its own specific problems.

Present knowledge of bottom fishery resources is fairly well advanced as compared to the pelagic. Modern otter trawling methods have undergone a progressive evolution and now occupy a place of prominence in world fisheries. In the Gulf of Mexico shrimp and ground-fish trawl fisheries are major components of the industry. In addition, oyster, scallop and clam fisheries, and to a large extent, the blue crab fishery are all dependent upon benthic stocks and bottom gear.

Regarding the pelagic division, however, knowledge is less complete. This area may be subdivided into a surface layer and a midwater region, again for convenience.

Most pelagic fisheries now existent depend upon the fauna of the surface layer. In the Gulf purse seining, gill netting, trammel netting, and some beach seining have been carried out in the bays and along the coast line. Menhaden, mullet and Spanish mackerel have been among the principal species sought to date. Sporadic observations of additional life in the surface layer have been made throughout the years on a subjective and more or less hit or miss basis by persons primarily engaged in other pursuits. Lack of adequate gear and methods of coping with the smaller school fish often reported and a lack of market have combined with a low level of interest to prevent progress in this field. The accumulative impact of the reports has, however, resulted in increasing interest in the past few years.

Recent Interest in Pelagic Fisheries

With the increase in overhead and other expense associated with the complexity of large, modern, refrigerated menhaden vessels and gear, this fishery has become interested in increasing its operations, presently occupying the factory equipment for only a few months of the year, to a full time basis. They have, thus, recently been seeking information on school fishes other than menhaden for reduction use in the off season.

Another industry segment, the so-called "Industrial Fish" fishery, has also recently become interested in the school fish potentials in the Gulf. Originating primarily as a trawl fishery, this operation has undergone a tremendous growth since 1952 with several plants set up in Louisiana, Mississippi and neighboring states for the production of canned pet food and, more recently, high quality, vitamin enriched meals.

Advances in the field of marine electronic devices since the war have opened the midwater reaches to observation, and recorded indications of fish schools have caused some interest in this area as a possible commercial fishery site. In contrast to the surface school fisheries, which depend primarily upon visual observation, hence are restricted to the relatively shallow layer herein designated "surface," modern depth recorders and scanning devices make it possible to "pick up" schools beyond the reach of visual observations. Thus, a region many times the volume of either surface or bottom regions is theoretically opened up. The major difficulties in utilizing the area involve methodology, efficiency of present gear, plus an almost complete lack of knowledge of the species of school-fishes involved or their available quantity.

Thus, in the pelagic fisheries alone there is a basic schism which will necessarily involve two types of operation—surface and midwater. It is with these two areas and the problems of pelagic fishing that the *M/V Oregon* is presently devoting the principal portion of her operational time.

Oregon Activities

Close to a year ago, the *M/V Oregon* temporarily reduced her bottom explorations in order to devote near-maximum effort to the problems of pelagic fishery development. This investigation of midwater and surface school fish potentials was brought about by industry interest, regular and frequent sightings of schools by Fish and Wildlife and commercial vessels in the Gulf and the encouragement voiced in a recommendation by the Gulf States Marine Fisheries Commission. At the outset the following definite objectives were decided upon:

1) Identification of school fish species.

2) Development of efficient methods of fishing and fishing gear.

3) Determination of geographic range and seasonal availability.

4) Determination of available quantity.

The project started off on schedule with a preliminary survey of the potential primarily in the eastern portion of the Gulf where interest was keenest. Principal gear used was a forty foot modified British Columbia midwater trawl of small mesh nylon webbing. This proved an excellent sampling device in most instances for schools picked up on the echo recorder. School samples were obtained over the area investigated, the principal school components have been identified, and a small reference collection has been built up of sardine-like fish species encountered. While main reliance during the survey was placed on detection of midwater schools by electronic means, a constant bridge watch of professional personnel and vessel crew was kept and observations of surface schools were made. The work is presently at a stage where the schools are known qualitatively with fair assurance of completeness, a start has been initiated at correlating fish species with the shape of schools as portrayed by

echograph tracings, and indications of a definite commercial-type potential have been found. Sampling activities pointed to the occurrence of at least six midwater species of fish in the Gulf in possible commercial quantities which are either not used at all, or are little used at present. They include:

1) Razor bellies *(Harengula p. pensacolae)*
2) Cigarfish or scad *(Decapterus punctatus)*
3) & 4) Anchovies (*Anchoa hepsetus* & *A. mitchelli*)
5) Round herring *(Etrumeus sadina)*
6) Thread herring *(Opisthonema oglinum)*

In addition, Spanish sardines *(Sardinella anchovia)* are seasonally abundant along the west coast of Florida. Chub mackerel *(Pneumatophorus colias)* and butterfish *(Poronotus sp.)* may also prove to be of commercial abundance.

The relatively large number of species encountered, each with its own behavior pattern, characteristic habitat, etc., has made necessary an exploratory attack utilizing a variety of gear types. It has also become evident that a project division into surface schools and midwater school-fish projects would facilitate investigation. For this reason the *George M. Bowers* is now in the Gulf primarily to aid in the surface school program. A California lampara and a West African purse lampara modification are now available for use with the *Bowers*. An hydraulic net gurdy has been installed on her afterdeck, and a west coast type, 20-foot seine skiff has been built for the operation. At present the *Bowers* is engaged in preliminary gear trials. The surface school investigation is providing an example of cooperation between industry and the Fish and Wildlife Service. A lampara operation, recently instigated by a local "industrial fish" concern, has been cooperating closely with our own. This operation is providing encouraging evidence that the lampara may be useful gear in the Gulf as well as on the west coast. The crew has all observed commercial operations in California and their net, approximately 350 fathoms, is cut and hung after California practice. So far, in spite of the invariable difficulties incident to a new method, considerable success has been met with on several menhaden sets in the bay. One desirable feature of the method is that large shrimp boats can be utilized with minimum change over.

The *Oregon* will devote the principal portion of her exploratory time to midwater school-fish work. Plans have been drawn up calling for the use of larger midwater trawls of 100-125 feet square opening and gear modifications which we believe will increase efficiency. The recent acquisition of a telemeter is also an important step in this program. The telemeter is an electronic pressure sensitive unit which enables the vessel operator to tell by a glance at a bridge dial the position of his net. The instrument has been recently perfected by the Seattle Exploratory Fishing Section and is in limited commercial production. With this instrument to enable more precise location of the net in relation to echograph-located schools plus constant modification of gear and methodology, more thorough coverage—seasonal and geographic, and with further experience and observations of fish school behavior a more closely delimited idea of the availability of Gulf midwater school fishes to commercial-type operations will be obtained. A new fishery in the Gulf could well result. Towards this end, the cooperation of the Technological and Biological branches has been elicited as well as the efforts of the Exploratory Fishing and Gear Research Branch.

The Role of The Estuary in the Life History and Biology of Atlantic Menhaden

Fred C. June and J. Lockwood Chamberlin
U. S. Fish and Wildlife Service
Beaufort, North Carolina

There is at present a keen interest in estuarine research among marine biologists on the Atlantic Coast of the United States. The reason for this recent attention is the realization that man's activities in this environment may destroy a vital link in the life cycle of many marine organisms which support many of our coastal fisheries. The lives of many of these organisms, therefore, are dependent on the continued existence of this unique environment.

Between Cape Canaveral and Cape Cod there are approximately thirty-eight estuarine systems which are now known to provide an environmental link in the life history and biology of the Atlantic menhaden (*Brevoortia tyrannus*). There is no reason to doubt that most of the numerous unstudied estuaries along the Atlantic Coast also serve the same role. It is for this reason that detailed knowledge of the estuarine environment is essential for understanding the biology of this prolific species.

The findings which are summarized in this paper are based primarily on six year's study of Indian River, Delaware, an estuary located in the central part of the range of Atlantic menhaden. Additional observations over the past three years in thirty-four other estuaries from the Halifax River, Florida to the Sheepscott River, Maine, have furnished comparative and corroborative information.

In discussing the results, we should like to (1) summarize briefly what we know of the relation between the estuary and the events in the life history of Atlantic menhaden, (2) point out how certain physical and biotic features affect the behavior, distribution, and abundance of this species in the estuary, and (3) mention some of the problems concerned with the estuarine phase of our investigations.

The first event in the life history of this species associated with the estuary commences a matter of weeks, or perhaps months, after hatching of the eggs at sea. The larvae occur in large numbers outside the river mouths, and under suitable conditions they enter and become established within. Throughout most of the spawning season they can easily be obtained in large numbers at the river inlets by means of plankton nets suspended in the tidal currents. Hundreds of such collections made during the course of our work have shown conclusively that those made on the flood current consistently yield much greater numbers than those on the ebb. Furthermore, surface tows are much more productive than those made at intermediate depths and on the bottom. Yet the mechanisms controlling the orientations of the larvae which lead to their recruitment into the estuary are not understood. Entering larvae range from about eight to forty-two millimeters in length, but most are around twenty-six millimeters. At this stage they are rather elongated and quite transparent, with black pigment spots prominent on the lower surface of the body and about the head; they are devoid of scales, and the fins are only partially formed.

Entry of the larvae into the estuaries varies in time and duration in different

localities, but it occurs mostly in the late winter and spring months and may continue anywhere from two to seven months in a given locality.

Following their entry into the estuary, the larvae are found congregated near the upstream limits of the tidal zone in groups of many thousands of individuals. Here, and even during their migration from the ocean, they undergo metamorphosis into juveniles. During this transformation the body deepens, scales are laid down, all of the fins become fully differentiated, and the fish take on the color of the adults. The gut becomes highly elongated and convoluted, and the gill rakers, used in filter feeding, become much more numerous. This transformation commences at a body length of about twenty-six millimeters, but is retarded during the winter and early spring months. Larvae entering the estuary during the winter and early spring complete differentiation at a body length of about fifty-five millimeters, while those entering in late spring complete metamorphosis at about forty-two millimeters. As the fish increase in size, schools of the larger individuals spread out from the initial nursery areas and move farther downstream until a size gradient is established over their range of distribution in the estuary. It is of interest to note that this species has been observed schooling at the smallest sizes encountered in these waters.

After spending the summer months in the estuary, the schools of juveniles congregate in larger bodies inside the river mouths and eventually move out into the ocean. Generally, this emigration commences in late August in northern estuaries, while in southern estuaries, it may be delayed into January. At the time of their departure, the juveniles range in size from roughly fifty-two to one hundred and sixty millimeters in fork length.

During the following summer, as one-year olds, they support the bulk of the purse seine fishery along the south Atlantic Coast and in Chesapeake Bay, but large numbers occur in the sounds and rivers from Florida to the North Carolina-Virginia border. Indeed, two-year-old fish often are found in these inland waters. The relative proportion of these age groups which use such areas as post-nursery grounds has not been determined.

At least part of the adult population also utilizes the estuaries within Chesapeake Bay and along the middle Atlantic Coast, apparently for feeding purposes, during the late winter and early spring. They enter and leave these waters throughout the winter, but usually congregate in greatest numbers for a short period in late February and early March, after which time they are largely absent, although abundant along the adjacent coast.

In consideration of some of the specific features of the estuarine environment which relate to the biology of Atlantic menhaden, it would appear that food—its availability and kinds—is perhaps the single most important factor governing the distribution of larvae and juveniles. Examinations of stomach contents of the fish at these stages show that diatoms and holophytic flagellates form the bulk of the ingested material. The shallow waters of the upper tidal areas are particularly rich in these organisms, and here the menhaden are in the greatest abundance throughout the summer and remain latest in the fall. Nutrients essential to plankton growth are in strong supply in such areas, being delivered, in large part, by runoff from the surrounding countryside. The character and quality of the soil within the drainage basin and the extent of agriculture probably have a considerable influence.

Salinity appears to be a rather critical factor in the development and growth of the young fish. Larvae reared through metamorphosis in highly saline waters

at the U. S. Fishery Laboratory, Beaufort, North Carolina, for example, developed abnormalities in body form and structure, while those reared in reduced salinities developed normally. Repeated attempts to transplant larvae and metamorphosing individuals from the low salinity of the upper estuary to the more saline waters of the rearing ponds invariably met with failure. Yet, when such transplants were made several weeks after metamorphosis, they were successful. During March 1958, when prolonged rainfall had reduced the salinity near the Beaufort laboratory to about 10 ‰, larvae and small juveniles occurred in tremendous numbers in the area for the first time in the last four years. Several thousand were successfully established and growing rapidly in the rearing ponds until June, when reduced rainfall and high tides raised the salinity to near-oceanic values, and all juveniles soon died. Similar observations were made under natural conditions in Indian River, Delaware in March 1953 when heavy mortalities and structural abnormalities followed intrusions of highly saline water, occasioned by high tides and persistent, high onshore winds. These findings might be related to the delayed development of the water-balance mechanism of the euryhaline adult; however, they could also simply relate to starvation resulting from poor plankton production in the highly saline water at the times when mortalities were recorded. Histological investigation of the water-balance mechanism during its early development, in the light of the presumed fresh water or anadromous ancestry of menhaden, could be enlightening. Indeed, laboratory experiments for determining the salinity tolerences from the larval through the juvenile stages of development are urgently needed.

Water temperature also is related to certain life history features and behavior patterns of the fish. There appears to be a minimum temperature associated with the occurrence of larvae at the river mouths during winter. Over the past three years, for example, water temperatures below about 3° C at the mouth of Indian River have coincided with an absence of menhaden larvae in our plankton tows. When low temperatures have prevailed over a period of several weeks, we have found a high percentage of structural abnormalities, especially among the larger larvae, once recruitment into the estuary recommenced. Thus, water temperature during the period of entry may be a source of mortality in some years. A heavy winter kill of one-year-old menhaden in the Neuse River, North Carolina in February 1958 was attributed to freezing water temperatures which persisted over a period of two weeks. Also, all young menhaden being reared in the outdoor ponds at Beaufort (ca. 500) were killed during this period.

The fall emigration of juveniles from the estuaries also appears to be directly related to water temperature. Our records from Indian River indicate that it commences when temperatures in the estuary first fall below those of the adjacent ocean. Such a drop may occur in the shallow waters on each cold night after the end of August, each occasion being accompanied by a departure of juveniles. On the other hand, during warm periods in the fall, numerous juveniles reappear in this estuary. Comparisons of size distributions and meristic characters of these late inhabitants have shown that they were not members of the endemic summer population, but probably originated in estuaries north of Long Island and presumably entered the river while migrating southward.

Among the many problems concerned with our estuarine studies, perhaps the most difficult and important of these deal with estimating the relative

strength of a year class while it is still in the estuary and the mortality sustained during its stay in these waters. In attacking these problems, we have worked out techniques at Indian River which have been extended to other locations along the coast. One of these methods, for example, was applied in a number of tributaries from Massachusetts to North Carolina during the past summer. It essentially consists of marking large numbers of individuals by clipping the ventral lobe of the caudal fin and estimating the size of the population in the estuary from the proportion of recaptures in random samples. With this method, if the population chosen is too large, it is impractical to mark enough fish to obtain a reliable estimate. And estuarine populations of menhaden tend to be quite large. In consequence, the marking experiments were restricted to a tributary portion of an estuarine population. The question then arises whether such tributary populations can be found which are sufficiently stable to estimate reliably. That they are appears to be the case in those estuaries consisting of a central bay fed by a number of tributary streams. Earlier it was mentioned that the larvae and metamorphosed juveniles congregate near the upstream limit of tide. Accordingly, the population in an estuary during the early summer has been found to consist of a number of tributary subpopulations which, as the season progresses, partially merge in the lower reaches of the river. Initial attempts to estimate such a tributary population in late spring, when its integrity presumably is greatest, resulted in a high mortality among both marked and unmarked fish. However, by closing off a tributary creek with either a wall of netting, or a semi-permanent fence of galvanized hardware cloth, the contained subpopulation could be marked at such time when its constituent individuals were large enough to minimize mortality from capture and marking. Results have shown that the latter procedure not only results in virtually no mortality, but it can be applied in a large number of tributaries along the coast for the purpose of establishing an index of the relative abundance of a year class. The reliability of this method is being assessed from the results of other comparative methods of estimation which were conducted in certain areas; these include: (1) catch depletion from intensive seining, (2) school censusing, both from the surface and from the air, and (3) an absolute count of the fish in the fenced off tributary by trapping all individuals as they leave. Since some phases of this work are still going on, an evaluation of the results is precluded. If reliable, the marking method eventually may furnish a means for comparing the relative abundance from one year to another. Ultimately, of course, its reliability will be determined by its relation to the abundance of a given year class when the fish enter the commercial fishery as one-year-olds.

Further efforts along these lines have been concerned with the use of fluorescein dyes and radioactive tags. If practical means of marking and recovering larval and juvenile menhaden can be accomplished, by one or both of these techniques, they not only will be useful for population estimates, but also will yield information on the migration of the fish. Results of some of the laboratory work now await further trials. Suffice it to say that both methods offer promise of success.

A measure of natural mortality sustained during the estuarine phase of the life of Atlantic menhaden is, of course, entirely contingent upon reliable population estimation methods. The fin-clipping method, mentioned in the foregoing, indicates the mortality sustained only during the last few months that the

fish occupy the estuary. However, if we can achieve an estimate of mortality which would cover the entire period that the fish occur in these waters, it would provide the information necessary for determining whether conditions in the estuary are responsible for the success of a year class. Once we know the stages in the life history which sustain the greatest mortality, we can direct attention to the causative factors. The marking of entering larvae by means of a flourescein dye renders solution of this problem less remote.

A final problem deals with the need for a realistic evaluation of the importance of the estuary in the face of man's growing use of this environment. In its virgin state, an estuary is entirely kinetic, the result of natural influences, such as the shape of the basin (and its drainage system), wind, tides, rainfall, sunlight, temperature, etc. It fluctuates around its mean conditions, shifting little geographically, and remains, in most cases, a productive aquatic environment, only to the extent that these influences tend to balance one another quite rapidly. Even violent phenomena, such as hurricanes, floods, and droughts, which are often catastrophic to organisms in the estuary, are of relatively brief duration and have only an immediate, direct effect. Furthermore, natural catastrophies seldom influence more than a small part of the extensive range of an animal species such as Atlantic menhaden.

Man's activities are a striking exception. When he, at any time, alters the inherent balance of the estuary, he can never be quite certain of the result. Dredging, filling, marsh drainage, impoundments, recreational developments, and pollution are enduring influences seemingly destined to occupy all the estuaries on the Atlantic Coast. It, indeed, would be difficult to imagine an activity more purposefully devised to quickly affect all estuaries than the mosquito spraying program on the coastal marshes. The changes wrought in the estuary by such activities often are subtle, and it becomes especially difficult to measure both their immediate and long-term effects. Obvious, widespread, deleterious effects are not yet common, but one example of their far-reaching implications perhaps will suffice. Last summer we were called upon to investigate a mass mortality of young menhaden in a southern river which has been developed for summer recreational purposes. The number of dead fish which littered the beaches (to a depth of several feet in some areas) was estimated to have exceeded the total number of fish caught during the fall menhaden fishing season off North Carolina in 1957. The cause of this particular mortality was traced to industrial pollution. Such incidences of man's influence on the estuary are becoming more evident as his number increases.

The solution of these and related problems is not simple, but laboratories devoted to estuarine research along the Atlantic Coast are making headway. For only by continued, intensive study of the inherent and induced features of the estuary and their interaction can we, in time, hope to understand how they relate, not only to the biology of Atlantic menhaden, but also to all organisms associated with this unique environment.

New Purse Seining Techniques in the Menhaden Fishery Employing the Power Block

PETER G. SCHMIDT, JR.
Marine Construction & Design Co.
Seattle, Washington

THREE YEARS AGO a practical system of mechanically hauling fish nets out of the water was introduced on the west coast of this country. For many years various methods and mechanisms had been tried to solve this problem, but in each case they were either too complicated or not adaptable to the heterogeneous mass comprising a fish net. Some success had been obtained in British Columbia and the Puget Sound area of the State of Washington in the use of large drums, together with a spooling mechanism for handling salmon and herring nets. The partial success of this system stirred the imagination of many fishermen, and there was a willingness to try other new systems which were proposed.

The immediate acceptance and success of the new system using the Puretic Power Block* has been well documented in most of the fisheries journals throughout the world. To date, over 1,500 vessels have converted to mechanized fishing using the power block and other new techniques which have since been developed. In addition to the United States, this system has been introduced to many of the foreign fishing areas with considerable success.

The importance of the power block and a mechanized system for handling nets is far greater than would appear on the surface. In most fishing areas throughout the world, including the East Coast and Gulf menhaden fisheries, the crudest form of hand labor has been taken for granted in the fishing operation. Since before Christ, fish nets have been hauled by hand, and very few fishermen have seriously considered that a simple, practical solution could be found whereby their work could be lightened and made more efficient. It would be the same as if farmers everywhere assumed that the way the coolies cultivated rice paddies in Asia was the only way to accomplish this type of farming, because their imagination could see no other solution to the problem.

Mechanization had come to fish factories and fishing vessels in many ways, including the use of the airplane for spotting fish, fish pumps for brailing, and large, modern, efficient refrigerated fishing vessels. But little had been done to cut the manpower requirements or increase the efficiency of handling the net. Today fishermen and factory operators who have worked with us in applying mechanization to the handling of fish nets have found that this is just the beginning in the modernization of the fish-catching technique and the rational design of fishing vessels to best accomplish the job intended. More and more fishermen are coming up with suggestions and are willing to try new things than ever before.

Through the results that we have seen, it is safe to predict that the mechanization of handling fish nets will be the beginning of a long line of useful improvements which will make it possible for the fishing industry to keep pace

*A complete technical description of the Puretic Power Block and its application to many different types of fishing throughout the world, with suggested new designs of vessels, was presented in Hamburg at the 1957 International Fishing Gear Congress, sponsored by the FAO. Copies of this well illustrated paper can be obtained direct from the FAO, Rome, Italy, or from the author, 2300 Commodore Way, Seattle 99, Wash.

with agriculture and other industry in raising its efficiency and thereby increasing productivity. The use of electrical attraction in fishing is another step in the right direction, and in years to come it may make the use of nets and power blocks obsolete. In the meantime, we, as well as many others, are going to continue our search to improve the efficiency of catching fish by an objective study of each phase of the fishing operation, including the design and arrangement of the vessels.

After the introduction of the power block and the Puretic system to the West Coast, word spread rapidly throughout the United States as to the success of the method. In 1955, just five months after the introduction of the system, we were invited to attend the Gulf & Caribbean conference, to show a movie of the new methods. Those who saw the movie realized that we had solved the problem of pulling in a net on west coast fishing vessels and possibly the problem of pulling any net out of the water. There were still doubts as to whether this could be applied to the menhaden purse seine nets used on the Atlantic and Gulf coasts.

At that time we knew very little about menhaden, and even less about the vessels and systems that were used for catching this valuable industrial fish. We knew, however, that these purse seines were hauled from the water by more than twenty men, and that these nets were considerably smaller than most of the nets on the West Coast. It appeared that this would be a simple problem to solve. With the cooperation of a number of the leaders in the menhaden fishery an initial experiment was made at Fernandina Beach in December, 1955, using two conventional purse boats rigged with power blocks supported in rather crude davits. These first blocks were open on one side so the net could be easily placed in and out of the block. Enough was learned from that experiment to find out that: it was possible to pull the menhaden net with the rubberized V-sheave. There were, however, many operations connected with the system currently in use that would make it difficult to solve the problem without considerable developmental work.

This work was broken down into the following categories:

1. It was necessary for us to learn as much as possible about the present systems being used.
2. Power blocks which had previously been used could not easily be adapted, and it was necessary to design a completely new model which would adapt to the peculiarities of the menhaden system.
3. It would not be practical at this time to change the present two-boat system, but a system was required which could be used in the conventional purse boats with some improvements in design and arrangement.
4. A better method of supporting the block was required.
5. The system of handling the purse line needed to be revised.
6. An improved mechanical system of drying up the fish was required.

Rather than give a detailed account of what occurred from 1955 till 1958, let it suffice to say that this period was filled with experimental work coupled with some success and much failure. There was never any question of whether it was possible to pull the net from the water. The question was, "Can a system be developed which will cut down the large crew required and increase the efficiency of the operation?".

From the beginning most of the captains and fishermen were skeptical, and many of them were belligerently opposed to any system which would differ

from that which they had historically practiced. There were, however, a few captains who took a little more interest than others. One of these was Captain Wallace Lewis, who had done some experimenting with the blocks on and off during this period. In late 1956, Captain Lewis proved to himself and to the Standard Products Company that the system was feasible, and his firm took the lead in installing power blocks in four pairs of purse boats. The operation during the 1957 season of the Standard Products boats was successful, but not spectacular, inasmuch as they were pioneering the new system in practical fishing, and they dared not cut down the crew by the maximum amount thought feasible. For the 1958 season, however, each of the larger companies on the Atlantic Coast decided to convert to the new system and to take the maximum advantage of reduced crews. The following results were obtained:

Approximately 150 purse boats were equipped with power blocks, and all of the boats fishing from Long Island down through Lewes, Delaware, have converted to the new system. In Chesapeake Bay most of the boats have converted. All told, approximately 750 fewer men were used this year to handle the nets from Long Island to Chesapeake Bay than were used last year. Initially, the owners would have been pleased to obtain the same fishing efficiency and speed that they had before; however, it has been found that not only has the crew been reduced by ten men per net, but more hauls can be made per day. The work has also been made easier for the fishermen, who are now able to maintain their efficiency even after many hours of intensive fishing. Many other advantages are being found and one need only talk to captains, fishermen, and factory owners to learn of the success of the new methods.

A number of things had to be solved before the power block was a success. First of all, a far better method had to be devised to support the power block in the purse boats. After the initial experiments in Florida, it appeared to Puretic and others that a hydraulically-powered crane supported by a revolving mast would provide the ideal support. Much more development work was done on this crane than on the power block itself, because to handle the block and net as quickly and conveniently as possible it was necessary that this device could be easily and quickly raised and lowered and swung from side to side. Of the many details taken into consideration in the development of the crane the most notable feature is a pantograph motion which always supports the power block in a vertical plane, but allows it to swivel. Rubber shock mounts were developed to dampen the motion of the block in a seaway.

The problem of pursing was re-analyzed, and it was found desirable to introduce purse rings which could be snapped open, similar to those in use on the Norwegian herring nets. An alternate system is to use a Brummel hook, figure eight hooks, or other connector in the middle of the purse line to disconnect the purse line so that the rings would be free to go on up through the power block. At the present time most of the boats are using either the snap purse rings or a combination of the "disconnect" in the middle of the line, with a few snap purse rings on each end.

A better system had to be devised for drying up the fish or, in other words, lifting the fish up to the points of where they could be pumped. With ten or more men in each purse boat, this was done by physical brute strength. To gain any advantage from the power block, it was necessary to cut down the crew. With this reduced crew, it was not feasible to lift the fish by hand; therefore, something had to be developed to solve this problem before it would

be worthwhile to adopt the power block. Two developments have been made in this regard. The first is an adaptation of the West Coast strapping method, in which a fall is used which runs from the gaff on the steamer down to the bunt of the net. The bight of the net is gathered and lifted high in the air by this fall. At the present time, most of the steamers are using a two-drum winch for this purpose. A special hydraulic winch was devised by Marco which is being used by many of the boats. This winch operates from the same hydraulic pumping system which is used to lift the purse boats in the davits. With a two-drum winch and two single falls, it is possible to lift the bunt of the net up, hold it, and take another lift with the second fall, lower the first bight, and lift another bight of the bunt. Initially, when we proposed this idea most of the eastern fishermen thought that the bunt of the net would be torn by the tremendous weight of the fish. It was not until a group of fishermen visited the West Coast and saw this system in use in Canada that an attempt was made to adapt this to the menhaden net. Once it was tried, in the latter part of 1957, the captains caught on very quickly, and this has been a great help in making the new system possible.

The second factor in solving the problem of lifting the fish to the pump has been the use of electrical attraction. A number of boats have been equipped with an electrical system, which helps lead the fish to the pump. This speeds up the pumping operation and eases the job of drying up. Unfortunately, with large sets, a number of fish still appear to either be stunned, or to die in the process, and it is necessary to use the winch and straps in addition to the electrical device. Eventually this problem may be solved.

One of the major factors in the success of the new system has been the use of larger and more stable purse boats. The outstanding boats that have been developed so far are the aluminum purse boats built by RTC Shipbuilding Company of Camden, New Jersey. These boats have proved that aluminum is a superior material for use in construction of boats for this service. To gain a better fishing platform, it was desirable to make the boats longer and wider. To do this out of steel would have made them so heavy that it would have been impossible to lift them with the existing davits and boat-lifting gear. By the use of aluminum the hulls of the boats are about 50 per cent lighter than the older, smaller steel boats. These bigger aluminum boats are thirty-four feet in length with a nine foot beam, and have vastly improved operating characteristics. The bigger, lighter boats are dryer, more stable, and more seaworthy. This allows the fishermen to fish in much heavier weather, and to obtain more of the potential out of the mechanical net hauling methods. They are more convenient boats to work in for the large size has allowed some rearrangement which includes placing the purse winch and davit forward of the engine. This rearrangement is but the first step in the complete reanalysis of the purse boat design, and much improvement still can be made. In this regard, the author's company has completely redesigned the purse boats into what we feel would be a much more efficient operating platform.

Finally the success of the system has been helped by the many little things which have had to be unlearned and new things learned in the operational procedure which uses a crew of five less men per boat. No longer are there hands and bodies swarming over the boats, available for all kinds of details in the operation; likewise, the problem of teamwork and coordination is simplified with the smaller crew once they become well trained. Now that nearly

two-thirds of the menhaden fleet has converted to a new and more efficient fishing procedure it is suggested that they not rest, but continue to experiment with such things as improved pursing techniques, including the use of wire purse line for the purpose of reducing purse line expense and simplifying the pursing operation. The fishermen should seek further rearrangement of the purse boats into a more efficient fishing vessel, modification of the hull lines of the purse boats to allow better use of net protection in the stern, and continued experimentation in a thorough and systematic manner of widely different fishing systems, including the use of small catcher boats. The development should lead to each working a net by itself, together with carry-away steamers, and larger self-sufficient seine boats similar to those used on the west coast, but designed specifically for catching menhaden.

It has been gratifying to see the results of a complete modernization of a historic method. Whether we realize the fact or not, progressive work of this type is being done in fisheries throughout the world, and in many cases the underdeveloped areas are producing fish with cheaper labor at less man hours per ton than we are in this country. We must devote every effort toward mechanization if we are to maintain and improve our present position in world fisheries.

The Use of Electricity in Commercial Fishing in the Sea

CONRADIN O. KREUTZER
Smith Research and Development Company, Inc.
Lewes, Delaware

THE USE OF ELECTRICITY for the purpose of fishing goes as far back as the beginning of the century. The oldest literature about electric fishing with direct current known to me was written in 1908. Since that time the application of this fishing method has increased steadily, especially in middle European countries.

At the same time fresh water fishing with electricity was introduced, physiologists started to examine the specific reactions of fish under the influence of electric fields. Depending on the voltage to which the fish is exposed, three different reactions can be observed. At a certain minimum voltage in the water, the fish shows a jerking of the whole body and will escape from the electric field. If the voltage necessary for the escape reaction is doubled, the fish will not swim out of the field, but in the direction of the current field lines toward the positive electrode. If the voltage is increased again by the same amount, the fish will stop all swimming movements, turn over on one side and go into a state of narcosis. If the current is disconnected soon the fish immediately recovers from the narcosis, without suffering any damage.

The threshold values of the necessary potentials for each of these reactions is found to be constant for fish of the same species, independent of the length of the particular fish. If the chosen voltage in the water is just enough to reach the reaction when fish of a certain desired length will swim toward the positive electrode, smaller fish will have a potential across their body which will only

be enough for an escape reaction. This fact makes it possible to select certain sized fish.

In salt water we find the same three reactions of electricity on fish as in fresh water. Nevertheless, electric catching methods could not be introduced on a large scale in either the salt water fisheries, or in fresh water fisheries, since the reach of the electrical field is only 40-60 feet, and it must be considerably longer than this to be economically feasible. A serious further problem is created in salt water since to create electric fields of the necessary strength in a medium of such high conductivity, extremely high currents are necessary.

The first difficulty—the necessary high power requirement—can be overcome by turning on the electric field for only a very short time and then turning it off for a relatively long period. The fish behave in such an interrupted field about the same way as in a continuous field. The effect is similar to that in motion pictures. Here the eye gets the impression that the screen is continuously lighted, although there is between each individual picture a relatively long dark period. Only if the projected pictures per second are below a certain number can the eye see the dark periods. The same effect is achieved electrically with the fish. If the number of current pulses per second exceeds a certain number the fish will react a similar way to that in a continuous field. The ratio of the "on" and "off" periods determines the saving of electric power.

For the second difficulty, which is the short reach of the electrical field, a solution has not yet been put into application. But even with the short reach of the present gear there are certain applications which can be utilized. For example, in the North Sea, schools of large tuna weighing about 500 pounds and a length of approximately 10 feet are caught commercially with hook and line. When these fish take the hook, they put up a vigorous fight and many are able to escape, particularly the larger fish. To avoid this loss we developed gear using the hook as an electrode and stunned the fish as soon as they took the hook. In this case a high enough current is sent through the hook into the water so that the voltage across the fish is sufficient to stun it. This fish can then be brought aboard without any fight. The reach of the field in this application does not have to be large since the hook is already in the fish's mouth.

A second application where even the short reach of the electrical field can be utilized, is in the menhaden fishery. Menhaden are caught with purse-seines. After the net is pulled in the fish are concentrated in the bunt, which is about thirty feet deep and approximately twenty feet in diameter. The fish are then pumped from the bunt into the boat.

In this operation the fish, which are usually at the lowest part of the bunt, have to be raised to the surface. They can only be pumped if they are concentrated to such an extent that they are not able to escape the suction of the pump. The raising can be done either mechanically or manually, by the crew. The raising of large sets of 200,000 fish and more is difficult and sometimes such large sets are lost. Therefore, we developed equipment using the pumphead as the positive electrode, sending a current into the water that causes the fish to swim toward the pumphead, thus concentrating them. When the current is turned on the menhaden will rush within a fraction of a second to the pumphead and will be caught by the pump. The end of the hose does not have to be close to the surface but can be lowered as far as desirable.

It might be expected that all the 100,000 to 200,000 fish in the net would swim toward the pumphead at the same moment, but this does not happen. The

first fish reaching the pumphead form a dense sphere around it. These fish have a considerably lower conductivity than the surrounding sea water, so the cage which is the anode is insolated to a certain extent towards the water and a considerably lower current will flow into the water. The reach of the field is thus lowered and no more fish will swim toward the pumphead. When the fish get pumped away, more current will go into the water and new fish will be attracted. In this manner a certain equilibrium is reached between the amount of fish attracted and the ones pumped away. This dense sphere of fish has a diameter of four-six feet. If, due to the rolling of the boat, the hose is raised and lowered the ball of fish will go up and down with the pumphead as if it were part of it. The ball of fish with the pumphead can be raised out of the water up to one quarter of its diameter without disintegrating.

This process has the advantage that it is no longer necessary to raise the bunt with its heavy weight of fish, and that pumping can be started as soon as the hose is overboard. We have not lost a set, even large ones, with 300,000 fish. If large fish like sharks are in the bunt, they will be stunned and fall to the bottom of the net and can not be sucked into the pumphose, avoiding the common circumstance of a pumphose blocked by a large fish which can cause considerable loss of time.

The question is naturally raised how members of the crew would be protected against being hurt by the electricity. We have solved the problem by constructing the control-circuits in such a way that the current can only be turned on if the electrodes are under salt water. There was still the possibility that a man could fall into the part of the water which is penetrated by the electric field. Fish react at voltages of about 1.5 volts, but a human being does not feel the voltage until it reaches at least twenty volts. At the field strength used in this operation a six foot man would have about ten volts across his body as he falls into the water, and he will not feel or have any ill effects from this experience. It would take twice the voltage for him to feel it and many times this voltage to hurt. In order to prove to the crew that it was not dangerous, one of our men dressed only in his trunks, swam close to the electrode with the unit in operation.

DISCUSSION

Industrial Fisheries Session

Discussion Leader: Howard O. Sturgis

Discussion Panel: Raymond L. Haynie, Jr., Jack T. Styron, John S. Robas, Wayne M. Waller, T. A. Barber

Technology of the New Industrial Fish Industry of the Central Gulf of Mexico

Travis D. Love

Q. Haynie: You classify these species as industrial fish. How do you determine whether a fish is a trash or whether it is an edible fish or a sport fish?

A. Love: This depends partly on vicinity. For example, in the north central Gulf, where we are working, there is no large commercialization of croakers for food, so at least 99 per cent of the utilization of croakers as well as of anchovies, razor-belly herring, and round herring falls in the classification of trash fish.

We anticipate in the future that there may be a conflict in the designation because our technology laboratory is now doing work on the canning of several of these species, notably on the anchovy.

As far as sport fishing is concerned, the only one of these fish large enough to eat is the croaker in Lake Pontchartrain. At this time there are a few hundred pounds of so-called bull-croaker caught by sportsmen. Most of what we have called industrial fish would never get big enough to be of interest to the sportsman.

Q. Styron: In using trash fish for mink food, is the fish frozen?

A. Love: Yes. The whole fish is frozen in 50 pound blocks and shipped under refrigeration.

Q. Robas: Concerning the problems of the thiaminase content of certain fish which you use for feeding mink, some years ago we investigated the possibility of using frozen menhaden press cake on the theory that pressing reduced the water content considerably and that the cooking had destroyed the thiaminase. Has this been tried in the Gulf?

A. Love: I have no information on that.

Q. Robas: You mentioned that the trawlers which fish for trash fish are paid $35 a ton for their fish. Can you give us more details on this?

A. Love: The company doing the biggest part of the packing, rather than deal with the fishermen, has set up a broker system. The plant guarantees the broker a price and he in turn guarantees the boat crews a price of $35 a ton. The broker has enough boats under contract that they sometimes must

wait to unload. This is the reason he guarantees them this high price, so that they will be willing to sit at the dock and wait to unload.

Q. Waller: How much further expansion can this industry expect? You show that only a small area was being exploited; is this the extent of the resource?

A. Love: No, only a small part of the potential resource is now being utilized.

Holston: (Comment) In our College Park Laboratory we are conducting nutrition studies on the use of unprocessed menhaden as a possible form of animal food. The results to date have not been too gratifying. There is a possibility that there may be more than one antimetabolite, such as thiaminase, present, or some other factor that we as yet do not recognize. There will not be any immediate market for unprocessed menhaden.

Recent Accomplishments in the Fish Oil Utilization Program

JOHN HOLSTON

Q. Haynie: As some of this work is complete, what plans does the Service have for the dissemination of information to the people that it will help? How are we going to get the refiners or the users of this stuff to look at it?

A. Holston: As soon as enough scientific data are available, we publish the Technical Supplements to the Commercial Fisheries Review. There has been one on the fish oil program, one on the fish meal program; we expect within the next month to have the second one on the fish oil program and sometime perhaps in January or February the second one on the fish meal program.

There is a six to eight months' delay in publication in scientific journals. We try to prevent a lag in the dissemination of knowledge by means of Digest Reports that we distribute to a limited number of people on a quarterly basis.

Thirdly, we are making a collected bound volume of reprints of technical publications that appear in outside journals. These will be available on an annual basis for study at any one of our major laboratories. The actual problem of distribution I will leave up to you and your treasurer. I do not know how we will do that.

Q. Styron: Most fish oil producers are interested in the product finding its way into a product in some volume. When you talk of leather tanning and ore flotation and insecticides do you know what volume is involved?

A. Holston: I cannot give you exact figures, but in the case of ore flotations process alone the figures are astronomical. Ap-

proximately one-half pound of fatty acids per ton of ore is used and in over a year this alone would require more fish oil than is presently produced in the United States.

Q. Barber: I think the Fish and Wildlife Department should have a man who has had experience in the industry so that he could interpret technical data to the numerous industries. This man might develop certain information which could be referred back to the institutions doing the research work so that they might carry on along certain useful new lines.

A. Holston: This was the whole point of my paper this morning. We feel that it is time that the industrial fisheries paid as much attention to organic chemistry as they do to nutrition.

Q. Robas: So far, the discussion this morning has been related to American fish oil problems. I would like to point out that we are fortunate to have with us three men from Mexico who are presently building a fish reduction plant on the Yucatan coast. Now, Mr. Holston, imagining yourself in a remote area in the Caribbean where technical skills are few and where anyone producing fish oil will have to start with a crude product, is there any presently simple chemical process for removing some of the triglycerides from fish oil?

A. Holston: I think it would be a much easier job to remove the non-saponifiable matter and the stearin contents and what he had left would be very highly enriched in triglycerides.

Q. Robas: Isn't it true though that most of those processes start out first with refrigeration which, in remote areas, is difficult and expensive?

A. Holston: Yes.

Exploratory Fishing for Sardine-Like Fishes in the Gulf of Mexico

JOHN THOMPSON

Q. Styron: Is the midwater trawl a net that has proved to be efficient in other areas?

A. Thompson: The midwater trawl of the pattern that we are using, a modified British Columia type trawl, has been used in northern waters where tremendous hauls have been made. In fact, one of the difficulties with the net is the fact that it runs into dense schools which at times tear the net apart. With the advances in electronics, and a device for measuring the tension on the net we will be able to avoid tearing the net.

The Role of the Estuary in the Life History and Biology of the Atlantic Menhaden

FREDERICK C. JUNE AND J. LOCKWOOD CHAMBERLAIN

Q. Haynie: Do you think that sufficient emphasis has been placed on

the consequences that could result if we continue to destroy our estuaries?

A. June: I do not think that there has been enough emphasis on the importance of estuaries. Many fishes must have these waters for completing their life cycle. While all of the activities such as dredging, filling, and spraying may have little effect by themselves yet the sum total of all these may seriously affect our fishery resources. These problems keep coming up. One in particular is in Narragansett Bay, where consideration is being given to the construction of a barrier across the bay for hurricane protection. Another is in Delaware Bay, where serious consideration is being given to the construction of a barrier across that area. As time goes on more and more of such activities are coming into being. We must be concerned not only with the immediate, but also with the long term effects of such activities on our fisheries.

Q. Styron: Do you think that the data you are getting on the Atlantic menhaden will be of assistance in studying those in the Gulf?

A. June: The menhaden of the Gulf are entirely different from those on the Atlantic coast. However, there are certain similarities and there is little doubt that the information which we are getting on the Atlantic Coast menhaden will apply to a useful extent to the Gulf menhaden.

Q. Robas: You mentioned this morning a southern river where industrial pollution resulted in massive killing of menhaden. Would you give me the name of the river and the year?

A. June: It was in1957 in the Pamlico River, North Carolina.

Q. Robas: Do you know if anyone has ever studied the tolerance of juvenile or larval menhaden to the pollution from paper mills?

A. June: There are no such studies to my knowledge.

Q. Waller: Should we expect an abundance of menhaden in the Atlantic next spring?

A. June: From our look at the estuaries along the Atlantic Coast this past summer we think that there are more menhaden in the 1958 year brood than there have been in any of the previous year broods which we have examined.

Q. Menzel: Have adverse estuarian conditions caused the disappearance of menhaden in some of the northern areas, such as New Jersey?

A. June: We do not know to what extent changes in estuaries have affected the menhaden resources in the past. It would seem that the decrease in the water temperature, particularly the Gulf of Maine areas and slightly farther southward, had most to do with the disappearance of menhaden in those areas.

Q. Costello: Would you elaborate on your estimate of the abundance of pre-recruits?

A. June: We are interested in deriving an index of abundance of a year class in the estuary, and relating this with the relative abundance of those fish the following summer in the commercial fishery. This essentially consists of marking menhaden in tributary streams. We close off the mouth of the tributary and mark the fish by clipping off the lower lobe of the caudal fin. We estimate the number of fish in that population from the proportion of the recaptures in samples of random catches. Tests on mortality resulting from fin clipping show virtually no mortality. We also hope to utilize fluorescein dyes for such population estimates. It would seem that dyes could be most effectively used by dyeing the plankton, letting the fish eat the dyed plankton and utilizing ultra-violet light for determining the number of marked fish that were in the population.

The Use of Electricity in Commercial Fishing in the Sea

CONRADIN O. KREUTZER

Q. Haynie: Where do we go from here?

A. Kreutzer: We hope one day to be able to fish without nets. We want to develop a greater "reach" of the electrical field.

Q. Styron: How elaborate is the equipment that is necessary to do what you showed this morning?

A. Kreutzer: It is a very small apparatus that is used now [about 2¼ feet by 1½ feet by 2 feet]. We use the power on the boat, between 10 and 30 kw. The apparatus works from any kind of voltage or current, AC or DC, 110 or 220.

Q. Styron: What is the distance over which you are able to control these fish?

A. Kreutzer: A distance of about 15 feet. If you want to use stronger units, you can attract them from farther distances, but that is not necessary in this case.

Q. Styron: Have you found that the use of this method has any effect on the hulls of boats as far as electrolysis is concerned?

A. Kreutzer: The whole unit is insulated from the boat and no current goes into the boat which can cause any electrolysis.

Q. Waller: Is this device available for lease or sale to industry?

A. Kreutzer: It will be available.

Q. Smith: I think that this is a major step in the engineering and technology of catching fish. But carrying this on a step forward, one naturally wonders how this can be extended to the utilization of electrical fields extending over a considerable distance, which would appear to be a revolutionary thing if it can be done. In this connection, I remember some experiments carried out thirty years ago in Plymouth on the schooling of fish which seemed to indicate that the direction of travel of schools of fish depended partly upon the movement of individuals. Individuals at the tail end of the school would exert comparatively little influence on the

remainder of the school, but if individuals in front of the school strayed out in a different direction they would exert more influence on the remainder of the fish. So, a comparatively small proportion of fish in the vanguard moving to one side would cause the remainder of the fish to follow them. It occurs to me that the use of a comparatively restricted electrical field to motivate the leaders of a school might induce the entire school to follow them. You mentioned that you have already considered ways in which the electrical field can be extended, and I would like to have specific information on that point.

A. Kreutzer: At present we use the electrical field like the light that goes out in all directions from a light bulb. It decreases in strength after a very short distance. But like the light, the electrical beams can be focused with a mirror so that the current in the water can be sent out like a light beam for long distances. For example, there is the possibility of leading the electric current in the water by laying a cable on the ground of the ocean, maybe five miles long.

Q. Chapman: What is the effect of attenuated current on the outer edges of the school? I assume we are working with a hemispherical field and at the outer edges do you get an escape reaction by the fish?

A. Kreutzer: No. At first we thought we would get an escape reaction, but we did not.

WEDNESDAY—NOVEMBER 19

Chairman—DONALD Y. ASKA, *Chief Education and Market Development Branch, U. S. Fish and Wildlife Service, Washington, D. C.*

Selling Fish with "Point-of-Purchase" Advertising

O. H. STARK
Snyder and Black
White Plains, N. Y.

FIRST, let us define "point-of-purchase" and "point-of-sale." Point-of-sale can supposedly be made in the home as a result of reading an ad or watching a TV program. Point-of-purchase is a sale made in actual goods at the point where it is sold. Recent figures show that only two per cent of items in a supermarket are pre-sold.

One trade association offers $100 for the best definition of merchandising. This has been offered for the past five or six years and is still unclaimed. To me, merchandising is selling, but this must be three-level selling. For example, in the distribution of fish, the broker, grocer and consumer must all be sold to make any merchandising plan effective.

Point-of-purchase displays are one of the recognized advertising media that most effectively carries out a merchandising program; furthermore, it is the one medium that every salesman can help control, be more effective in, and actually see the results or benefits derived therefrom. Although other media are a necessary and helpful part of any well-conceived merchandising program, it is necessary to wrap it up and carry it through with a point-of-purchase program.

Since the war display material has gained new prominence. It is no longer just a part of the advertising and merchandising picture, but is now a recognized advertising medium in its own right. Even with years in the business, I am not always aware of its value and acceptance. This was vividly demonstrated recently when I spoke to the Pennsylvania Retail Grocers. I had hoped to sell them on the value of point-of-purchase materials, but this was not necessary. They told me they knew the value, would use it, and asked where they could get more displays. Display is now a major factor; do not treat it lightly.

The vehicles of displays are numerous; floor bins, wire trims, shelf talkers, etc. The uses of these vary with locality and type of store and constantly change. It is true that some stores claim they do not use display material, but when sales fall off a little, they scramble for display material. If personnel of a store claim they will not use dispay material, in six months they will probably completely reverse their thinking.

In any display program you must first make certain it is acceptable to the dealer, thus insuring usage. It can usually be tailored to fit a budget.

The need for display material that sells is greater than ever before. Mr. Armstrong, Director of Merchandising of Kroger Stores, says "Will the manufacturers please have their salesmen stop telling our buyers about all the wonderful advertising on the product. We presume you have ample advertising or you would not be on our shelves. Instead, please tell our buyers what you propose to do at the point-of-purchase to help move products from the shelves as effec-

tively as we put it on there." Also, I would like to quote Mr. Justin Dart, President of Liggett Rexall Stores, who stated before the Merchandising Executives Club of New York "There is nothing, absolutely nothing, that will replace merchandising at the point-of-purchase."

On this point, you should educate your salesmen as to the value of display in the store. In essence a display card, shelf talker or other form can mean extra dollars in his pocket if he will study where, how and in which store it should be placed. Many companies dramatize sales in terms of cash in a salesman's pocket. The salesman understands this language, thus insuring greater placement for you. Also on this point, even for large chain food stores you will be wise to erect a display, photograph it and keep sales records as to performance in terms of sales. When calling on another store, even in the same chain, show the photograph and sell it in terms of dollar sales. While on this subject, fisheries people have an excellent impulse item which can mean sales day after day. You also have a high profit item for the grocer. A grocer has items he makes money on and items he makes money with. Your product falls into the latter, and he loves these items.

Many items in a supermarket are impulse; in fact, over 50 per cent of sales are impulse sales. The Coca-Cola Company states that over 44 per cent of their sales in these stores are impulse sales.

Remember these stores are looking for good display ideas. I know from experience and from inquiry that fish products as a whole are not merchandised. You know more about movement of your product than the wholesaler knows. He will welcome you with any idea that will sell more.

The large food stores do 60 per cent of their volume in twelve to fifteen hours of the week. During these peak hours display is all important in plus sales to you and the grocer. As a housewife shops she sees only seven or eight per cent of the items, or approximately 287 items, from the thousands the store carries.

The stores are seeking selling displays as well as displays that create excitement. Mr. Myer B. Marcus, Vice President of Food Fair Stores, recently stated that displays keep their stores live and interesting and that in serving many of the same customers each week displays are a valued impulse factor to overcome the inertia of a shopping list which stifles sales.

If nothing else, please take home one important fact: "Product promotion without point-of-purchase is wasted money."

In addition, sell your own salesmen on your display program as well as you sell them on your product. As high as 84 per cent of the effectiveness of a display program can be lost from the time it is conceived until it reaches its final use, due to poor selling to your own organization.

In closing, please try something new. If you can't get local help on display, at least take an afternoon off, go to a supermarket and look for a display that you can alter or adapt to your products. In some manner either steal or buy the display. Rework it and run a few tests, and you will be amazed at what you can do at point-of-purchase.

What Research Can Contribute to Fish Marketing

W. R. Simmons
W. R. Simmons and Associates Research, Inc.
New York, N. Y.

Since the war there have been some revolutionary developments in the field of marketing and merchandising. In industry after industry enormous strides have been made towards improving the efficiency of the intricate processes involved in getting merchandise in the hands of consumers. In all but a very few industries, the comparatively new and rapidly growing field of market research has been highly instrumental in determining the direction of development of new marketing and promotional strategies, tactics, and procedures. Perhaps the fish industry has been less affected by these developments than many others.

A contributing factor in these developments has been the ever-increasing sharpness of competitive practices, not only between brands but also between product categories. We have been progressing steadily towards an era of enlightened awareness of the ways to influence and even to control the factors which make for a greater effective consumer demand. No longer do leading producers in an industry sit on their hands and offer mutual condolences for the sad state of affairs which prevent their company or their industry from achieving its rightful place in the economic system. Instead, individually and collectively they seek positive solutions to their problems.

Progressive producers seek to determine what actions are necessary to improve the individual company and the industry, to reverse trends if this be needed, to uncover new and different uses for their produce so as to render it more acceptable to a wider range of customers, to increase its prestige in the eyes of the consumers, to render it more satisfying, rewarding and attractive to more and more customers, to alter basic attitudes and beliefs that may be unfavorable towards consumption of their produce. These are but examples of many directions in which individual producers and entire industries can and have moved to increase their prestige.

The very nature of these possibilities for improving what is good, or changing what is bad about an industry, points to the research approach as an indispensable aid. Without it, the producer and advertiser, however knowledgeable in his own field, lacks essential information necessary to reduce the guesswork surrounding his decisions. He runs great risks, in taking any potentially effective step, of having it backfire, with serious or perhaps disastrous consequences. At the very least, without research he would have disregarded modern and progressive means of increasing immeasurably the efficiency of his promotional efforts, so that a million dollars spent in this direction achieves only what might have been accomplished for half-a-million spent more wisely, with more complete and accurate knowledge of where, how and what should be promoted.

The field of research has become so broad, and indeed some of its inquiries have penetrated so deep, that it is hard to single out a few areas of inquiry as being potentially more useful than others. Indeed, in the absence of a well-conceived research program operating over a period of time, a producer or an industry could start almost anywhere and come up with information that would be extremely useful—assuming, of course, that the research is sound.

Despite the progress research has made in recent years, every once in a while it is astounding to hear of enormously important decisions being made, involving millions of dollars of investment, without the aid of highly relevant facts that research could so easily supply. This certainly does not imply that research will become a substitute for administrative judgment. It must be suggested, however, that failure to inquire into available or procurable facts before reaching any important conclusion is hard to reconcile with either a scientific or a business-like approach. Far from being a substitute for administrative judgment, research must be considered a powerful and extremely effective ally not only as a means of testing hypotheses and assumptions, but also in stimulating creative imagination in new and highly promising directions that would never have occurred to anyone otherwise.

In turning to our more specific area of inquiry here today, what research can contribute to fish merchandising and marketing, it depends of course upon what you already know and what you want to achieve for the industry as a whole and for the individual producers. Granting the premise, however, that primarily you want to sell more fish at better prices, there are important services that research can render you. The need for research often cannot be ignored, for the more energetic and progressive activities of competitors may well make serious encroachments which will prove far more costly to repair.

Basically, research can discover for you genuine opportunities to increase sales. These opportunities may lie in many different directions, as, for instance, the capturing of new markets that could be induced to use particular types of fish products, ways to increase the frequency of serving fish, the ways of overcoming objections to the use of fish, ways of enhancing the attitude that fish are a major source of needed nutrients. Even more important, perhaps, research can delineate and describe the types of mental and emotional obstacles which stand in the way of greater use of fish. Thus, research can point the way towards their elimination.

All of these things, and many more, can be achieved, not as a result of a single research project, but as a long range result of a well conceived and executed program of research having many different facets relating to different products, different market groups, and different areas of inquiry.

Solving Problems in National Merchandising of Seafoods

Ed. Kausnicka

District Manager, Gorton's of Gloucester, Inc.
Atlanta, Georgia

There are many problems in merchandising seafoods. The seafood industry seems, at times, to be overly blessed in this respect. In fact, the word merchandising itself is a problem to define. What does it mean to the food technologist, the scientist, the packer, or the grocery clerk? To me it simply means leaving no stone unturned to sell more products.

The seafood industry is one of the oldest industries, with some of the oldest properties, oldest ideas, and oldest methods in the country. In spite of its age,

the industry is sorely inadequate in its informative advertising as to the nutritive values and health-giving qualities of seafoods, inadequate in education in the art of preparing appetite-appealing seafood dishes, inadequate in buying and marketing guides for the consumer, the retailer and the wholesaler. This is especially true today with the many frozen and prepared products on the market.

Instead of guiding customers, the industry tends to confuse them; instead of protecting its products at all levels of distribution, it tolerates their abuse; instead of sales being motivated on merits of quality, their promotion is based on price. While all of these things present problems, the solutions are comparatively easy. When we dig a little deeper, we find the "unturned stones," which, in my opinion, present our greatest obstacles. The matters of faith and confidence, sanitation and handling, stigma, dietetic information, and research and recognition, are worth investigation.

I was impressed with the objectives expressed by The Marine Laboratory in the letter inviting me to make this presentation. They said: "We are convinced, . . . that there is a great deal of research information which could mean money in the pockets of the industry, but which is not being used because its significance is not understood. On the other hand, scientists are sometimes inclined to work on problems of little use to industry, unless they keep in close touch with the real needs."

It seems strange that a group of technologists and scientists would invite men from the merchandising field to discuss what they feel is a mutual problem. Scientists would be happier, so I thought, discussing among themselves calories, proteins, other nutritive factors, enzymatic action, etc. However, I find that under the circumstances it is even stranger that the merchandising segment of the seafood industry did not invite science and technology to its meetings long ago. We still have the basic problem of how to increase per capita consumption of the food products our industry produces. The real needs so vital to solving that basic problem are so many we could make a long list. It may be better to set up just a few, in big print, so we could examine them thoroughly, analyze them, and then inaugurate a program that would add vitality, vigorous growth and inspiration to our efforts. This is essential before any sound merchandising plans can be developed.

Time will not permit a complete analysis, but for the sake of discussion, take a look at such items as faith and confidence on the part of the consumer, faith that we will produce food of the highest nutritional value, temptingly delicious, produced under the highest quality standards that technical and scientific minds can create.

The consumer is interested in consistency in seafood purchased as to flavor, freshness, food value and preparation. Can the consumer have faith in the product whether she buys it today under one brand, and next week under another brand; can the consumer have confidence in all types, species and brands of seafood? With some exceptions, I think not, until the entire industry comes under some semblance of rigid government inspection. High uniform standards must be maintained before and after the catch, at the dock, in the packing plants, in warehouses, on delivery trucks, and in the stores. This requires a far-reaching program exacting vigilance at every turn, but it can achieve objectives we seek if we will but remember that to put the finest product on the table we must start at the boat.

An even greater deterrent to increasing per capita consumption of seafoods is the ever present problem of the stigma attached to the word "fish." Consumers who rarely serve fish at home put up a barrier at the thought of fish. Apparently they promptly think of fish odors, burnt grease, messy kitchens, and anything else distasteful that they, at some time or other, encountered in the preparation of fish. If we ever hope to eliminate such mental pictures, we must attack this problem with every resource at our command. Perhaps the scientists and technologists can come up with a solution.

Rigid government inspection of all seafoods will bring about a new confidence and faith in our industry as a source of food, but it won't do the job alone, nor will its benefits reach out and secure new consumers for us, in whose minds the familiar stigma of the word fish still exists. It may even be advisable to remove the word fish from the industry's advertising and merchandising vocabulary.

Information expounding the healthful qualities of seafoods, how to care for them after purchase, instructions on the proper preparation of each species, and more promotional activity creating appetite appeal for products from the sea by new and different recipes glamorizing seafood dishes will help the merchandisers of the industry dispel some of the fixed ideas of the public as to seafoods. Some work has been done in this direction by government agencies. The Fish and Wildlife Service has done an excellent job with the school lunch program, and has assisted in an effort on the National Fisheries Institute's recent national fish and seafood week, together with contributions from various state agencies. The newspapers, too, gave us tremendous support in their food pages during our recent promotion.

Information to retail outlets is also essential to create a desire at that level for more prominent and attractive seafood displays. In terms of profits, our products play an important part in the economy of the nation's food business, but a little information through only a few existing channels, is not enough. More of this will have to be done, more money will have to be spent, and more consumer advertising will have to be purchased.

The basic fact remains that it is ridiculous to spend huge sums of money for advertising until the products themselves are basically right and readily acceptable in every way. Once this is achieved, we can go ahead with work on merchandising in the more practical sense, and gain all sorts of rewards. One in particular is imperative before the full impact of any merchandising efforts can be realized, and that is recognition by the top management of the business firms upon whom we rely for final distribution of our goods. But recognition is a reward that must be earned by acts and deeds for common good to be of value. Those of us connected with national fish and seafood week can tell you that except in a few isolated cases the seafood industry just does not command much attention where it is needed.

In the past several years I have attended conventions of the National Association of Food Chains, Super Market Institute, Cooperative Food Distributors of America, and Frozen Food Distributor Associations, and in all of them combined, our industry has not rated over 90 minutes of discussion. Even within our own industry we are almost totally lacking in the cooperative spirit so vital to the success of any national campaign.

We have several jobs to do and many problems to solve before adding practical merchandising ingredients to any sales motivation program. Paramount to

the many other more practical activities, the real needs of the future of the industry are:

1. Encouragement of industry-wide government inspection.
2. More research and education at all levels.
3. More consumer faith and confidence.
4. Removal of the stigma attached to the word fish.
5. Organization of our forces wholeheartedly for promotion of all seafoods on a national scale.

We must earn recognition, with the fervent hope that it will help us achieve any goal we may set, in an atmosphere of warm cooperation within the industry.

The Kind of Promotion that Food Editors Like

JEANNE VOLTZ
Homemaking Editor, The Miami Herald
Miami, Florida

FOOD EDITORS ARE an important link in food producers' efforts to tell the consumer the best ways to use their products. You may see the impact of a food editor in your own household. Your wife has two or three books and lots of recipe leaflets and pamphlets. She refers to them once in a while—on how long to roast a turkey or for a hot roll recipe. But who plants the thought of a new food—one she's never tried before—in her menus? A food editor, more often than not.

A newspaper is thrown on your doorstep at least once a day. Maybe a women's magazine comes to your house each month. Your wife sees a recipe in that newspaper or magazine for, as an example, baked mullet fillets.

If this woman were not a fisherman's wife she may never have seen a mullet, much less cooked one. The fillets in the newspaper picture look appetizing. The food editor describes the delicate flavor of mullet, its high quality protein at low cost. The recipe looks easy enough to follow.

"I think we'd like that," the homemaker says to herself.

If somebody doesn't wrap the garbage in the newspaper before she clips the recipe this woman tries mullet.

A good food editor makes sure the recipe is reliable before it is published. If the homemaker follows it carefully, she is a lifelong mullet customer. A food editor is your pipeline to the bride who has never cooked fish or seafood. She is your pipeline to the older housewife who doesn't like fish because she never learned that overcooking ruins flavor and texture. She is your pipeline to the woman who doesn't cook fish because she thinks frying is the only way—and frying makes the kitchen so hot. A food editor knows there are many ways to cook fish other than frying, but she wants help from you in telling the story.

Possibly a description of a food editor's job will show you how material from fisheries authorities can help her. Her prime interest is service to her readers, so any promotion of any industry should be aimed at the great reading public, with its quirks and great variety of interests. Her job is a busy one. I don't know a food editor in America who has time for everything she would

like to put on her food pages. Many food editors are one-woman departments. Her principal job is getting out her food page. Much thought, planning and searching for information go into this page. She selects pictures and recipes which appeal most to her readers. She may set up some pictures for photographing—a tedious job of selecting dishes and accessories and cooking photogenic food. She writes the copy, and it must be carefully written to be clear and to the point. She always works against a deadline. When presses start rolling if her food page is not in, it is too late. She gets hundreds of letters and telephone calls a month. "What makes my pie shell bulge?" "What's this conch (and new people in Florida call it that) you wrote about last Sunday?" or "How do you cook yellowtail?" her readers ask. She is barraged with mail from people who want her to use their products in recipes. Men and women come in person to put in a good word for their products. And there's the pest who brings a food product to her desk and says, "Give me a little plug on this!"

I think I speak for every food editor in the United States and the editors I know in Canada. If your approach is "Give me a little plug," you are not likely to get it. But if you provide good solid facts, new ideas and food news, a food editor welcomes your help.

No food editor in the land has time to develop all the recipes used in her columns and she cannot set up all the pictures. Some newspapers do not have competent food photographers, but even on The Miami Herald, with excellent food photographers, food competes with many types of news for photographic staff time. So a food editor depends on the food industry for much of the material she uses. We want an attractive picture, one that will make the reader think, "Oh, doesn't that look good!" If a picture does not measure up, it simply is not used. A food editor can be quite ruthless about throwing out poor pictures, for there are plenty of good pictures competing for space in her columns, and it is her business to attract readers.

The food editor needs recipes which appeal to a wide variety of tastes. She writes for people with all sorts of tastes and talents in cookery. She wants some quick recipes, and what is quicker than fish or seafood? She wants a few recipes for the woman who wants to impress the boss's wife with her cookery talents. These are the recipes with complicated sauces and the like. A food editor wants cook-ahead dishes for the reader who never serves fish because it is a last minute job. Chowders, gumbos, seafood curries and newburgs can be cooked ahead and reheated. In the recipe tell the food editor, "This dish can be reheated." If a reliable test kitchen supplies the recipe, a food editor can pass along the tip with complete confidence.

Many mothers and maybe food editors think children don't like fish. This is not true. A four-year-old was at our house for a month last year, and her favorite main dish was fish, but fish without bones. She ate fish sticks, broiled or fried fish if we peeled it off the bones, boneless fillets, shrimp and scallops, fish cakes. With a fish cake recipe, remind the food editor this is the way to serve fish to children.

Of course, I'm contradicting a current trend to make recipes and publicity releases shorter. Recipes and stories with them should be as short as possible. The average busy woman chooses a short recipe over a long one. I think food editors want any and all information pertinent to readers' problems of feeding their families. Pare down the adjectives to make room for useful information.

Most important, any recipe must be thoroughly tested. If a food editor is in

doubt about a recipe, she is apt to toss it in the wastebasket. She cannot afford to jeopardize her reputation for reliability by using a doubtful recipe. The recipe must be written in specific terms that any woman or man can understand. You and I know how to tell when broiled fish is done, but the bride may not.

I would like to see more seafood recipes which say, "Do not overcook." This is the major catastrophe of seafood cookery. Readers tell this tale of woe time after time—the fish was dry, the flavor was poor.

Developing recipes for food editors usually is a job for a publicity agency with a good home economics department. Such an agency has facilities for testing recipes thoroughly, and it has the staff to set up photographs. The National Fisheries Institute and Shrimp Association of the Americas are fortunate in choosing an agency known for reliable, tested recipes. The U. S. Fish and Wildlife Service also is an aid to food editors; I expect nearly every food editor uses Fish and Wildlife Service bulletins as references. We see Fish and Wildlife Service field representatives from time to time, so we can ask these men, "What about the snapper supply this year?" The Florida State Board of Conservation is unique, I believe, in having a home economist on its staff. She can do a close-to-home job by finding which fish and seafoods are expected in best supply and giving us recipes for them. We get frequent recipe releases from her.

Good photographs are another need of food editors. Newspapers are constantly having surveys made for them to study why food stories are, or are not, read. We know a recipe gets tremendously better readership if there is a picture with it, so we use few recipes without pictures. We know, too, that for good reproduction in a newspaper a picture must be sharp and clear, and free of too many or too dark shadows.

A food editor wants facts. Certainly, she knew a great deal about food or she never would have gotten her job. But her readers' questions can cover the universe—things she couldn't possibly know without asking the experts. Her readers are vitally interested in how to tell fresh fish from one not so fresh, so make sure food editors have a good, usable guide to selection of fish and seafood. Many pamphlets and the like provide this information, but make sure food editors have them.

A food editor wants to know when certain fish are in season. This is aid you can give on the local level. Let the food editor in your area know when a certain fish will be abundant. She may plan food pages weeks ahead. Notify her in advance of an expected abundance to give her an opportunity to arrange food stories on fish at the most plentiful seasons. A food editor appreciates beforehand information. She is eager to keep her food pages timely.

Another help fisheries men can give in their own cities is to acquaint food editors with locally available fish. A woman bred near the Great Lakes may be food editor of a Gulf Coast newspaper. Can you imagine what a newcomer from Detroit would tell a reader about conch if she was not warned he is a tough creature and needs special handling?

Keep the food editor in your city informed on new products as they come to market. A Fish and Wildlife Service representative told me of new frozen mullet products coming on the market soon. I knew my readers were interested, so this was used as a news item.

I think I speak for most food editors when I say we want to know fisheries marketing men in our areas. You are a source of expert local information. An

alert food editor often writes a national publicity agency handling a fisheries account with questions. But you know best if crabmeat or snapper will be in her home city markets next week.

And a word about getting your seafood market's name or a brand name in her columns: Don't expect it. Most reputable newspapers and magazines strictly forbid use of commercial or trade names in editorial columns. Name identification is bought and paid for in advertising columns. But when you cooperate in giving a food editor information you create an interest in fish and seafood. If you market the high quality seafood women want you will be rewarded.

A man in our office says to me jokingly many Thursdays, our big food page day, "Well, Jeanne, I see you are peddling shrimp (or whatever it is) today." A food editor doesn't consider she is peddling anything. Her prime interest is to serve the reading public. But her reading public also is a food buying public.

As a group, and individually, you can assist a food editor with recipes, pictures and facts. These are her tools in producing attractive, interesting food pages. You may call it promotion. The food editor calls it assistance. But if it is assistance it is the kind of promotion food editors like.

DISCUSSION

Fish Merchandising Session

Discussion Leader: MURRAY WHEELER

Discussion Panel: SARAH ALBERSON, CHARLES E. JACKSON, JOHN MEHOS, ROBERT M. INGLE

Selling Fish With "Point-of-Purchase" Advertising

O. H. STARK

Q. Jackson: What suggestion can you make for increasing sales of fish from the frozen food cabinet?

A. Stark: One approach is to sell a related item along with the fish and to suggest a recipe to combine the fish and that item. I would like to emphasize the importance of asking for opinions from buyers concerning your product. Pre-testing of new products is necessary. Also, get to the man who is in charge of a particular department in the store and find out what his likes and dislikes are. He can do more to push your goods than the store manager can.

Q. Mehos: What is the cost of point of sale advertising in relation to return, compared with other media?

A. Stark: Point of sale advertising is less expensive than any other type of advertising medium.

What Surveys can do for Fish Merchandising

W. R. Simmons

Q. Jackson: How do we go about finding out what is our best approach to selling more seafood?

A. Simmons: There are the tools of research which allow you to discover what consumers want. Almost any industry that I know of has a well planned marketing research program. There are so many weird things that happen in every market that it would be remarkable if it were not true for fish.

The Kind of Promotion Food Editors Like

Jeanne Voltz

Q. Jackson: Could you give us some information as to the potentialities that there are in barbecuing fish?

A. Voltz: From the middle of April through the middle of October we ran five major barbecue pages; that was about twenty-five per cent of our major food pages for that season. We are constantly receiving letters and telephone calls requesting information on how to barbecue foods, including fish and seafood.

THURSDAY—NOVEMBER 20

Chairman—SETON H. THOMPSON, *Regional Director, U. S. Fish and Wildlife Service, St. Petersburg Beach, Florida*

Parasites and Fishery Problems[1]

WILLIAM J. HARGIS, JR.
Virginia Fisheries Laboratory
Gloucester Point, Virginia

Introduction

ACCORDING TO THE LATEST CONCEPTS, diseases caused by living organisms are parasitic diseases. Thus a multitude of protistans, plants and animals, may be classified as parasites. Parasites inhabiting various fishery organisms have long been of great medical and veterinary interest, *e.g.*, the Asiatic lung fluke (*Paragonimus westermanni*) which is contracted by eating raw crabs and crayfish, the Asiatic liver fluke [*Opistorchis sinensis* (=*Clonorchis sinensis*)] and the European liver fluke (*Opistorchis felineus*) which are ingested with raw fish, and the broad fish tapeworm (*Dibothriocephalus latus*) which is often contracted by cooks preparing "gefüllte" fish from imported walleyes and pikes. Interest in parasites of fishes and other aquatic animals has been largely academic. Recently, however, these parasitic organisms have begun to attract the attention of scientists in applied disciplines, like fishery science.

Parasites and Fishery Populations

We have long been aware that parasites may seriously affect confined aquatic populations. Hatchery operations and food-fish ponds, to say nothing of aquarium displays, are often disrupted by outbreaks of parasitic diseases. Probably not infrequently natural populations have also been adversely affected. We have become increasingly aware that to manage natural fishery populations we must understand the dynamics of these populations. Thus, *all* of the important factors affecting the populations must be known. Walford (1958) points out that enough epidemics among fishery populations have already been reported to suggest that disease might be a more potent factor in marine ecology than is usually suspected, and suggests that past failure to include the study of diseases in marine research programs possibly explains why some of the causes of fluctuating abundance continue to be mysterious. This failure also probably partially accounts for our lack of understanding of certain periodic fish mortalities. Scarcely a year passes without late winter or early spring mortalities of the bay anchovy (*Anchoa mitchilli*), young menhaden (*Brevoortia tyrannus*) and other fishes in lower Chesapeake Bay, the causes of which are unknown. Similar unexplained mortalities occur more or less regularly all along the Atlantic Coast of North America and elsewhere (Sindermann and Rosenfield, 1954; Westman and Nigrelli, 1955; Sindermann, 1956). Little is known of the effects of "non-pathogenic levels" of infection upon the host, but undoubtedly there are some. Almost nothing is known of the comparative longevity of non-parasitized and parasitized populations.

[1]Contribution from the Virginia Laboratory, No. 83.

The list of parasites which produce diseases in fishery animals or their associates ranges from the virus which causes lymphocystis disease of fresh-water fishes, to bacteria, *e.g.,* some vibrios and chromobacters; to fungi, *e.g., Icthyosporidium hoferi,* which causes "pepper-pot disease" in herring and other fishes of the Western North Atlantic; *Lagenidium callinectes,* which parasitizes the egg masses of the blue crab *(Callinectes sapidus),* and *Labyrinthula* sp. which probably causes the wasting disease of eelgrass, and which probably adversely affected several valuable fishery populations in the pandemic of 1931 and 1932; to protozoans, *e.g.,* the many microsporidians and myxosporidians which attack fishes, decapods and molluscs; and to the helminths and crustaceans which, though usually relatively innocuous, may also produce debilities in their hosts. There are undoubtedly many other virus, fungus, bacterial, protozoan, and metazoan parasites of fishery animals which are as yet unknown. Knowledge of these parasites is increasing, however, because parasitological investigations are now included in several fishery research programs. A significant case in point is the attention recently given the fungus, *Dermocystidium marinum,* which causes oyster mortalities in many Atlantic and Gulf Coast regions. Before the importance of this fungus disease was demonstrated by Mackin *et al.* (1950), Ray (1953), and Andrews and Hewatt (1957), certain regularly occurring losses of many oysters were not understood. As a result of the efforts of these workers the pathogenic fungus has been identified and characterized and it is now possible to advise oystermen how to reduce losses from this pest.

Parasitological Data as Research Tools

Fishery scientists also are becoming more interested in using parasitological data as tools or clues in their efforts to resolve fishery problems. Parasites often exhibit marked geographic restriction and host specificity. These characteristics make possible their use as living indicators or tags.

Parasites as Indicators of Geographical Subpopulations

Studies of U. S. Fish and Wildlife Service personnel (Uzmann *et al.,* 1957) on natural populations of the sockeye or blue-back salmon (*Oncorhynchus nerka*) in the Columbia River system have revealed pronounced differences in the parasite faunas of migrants from the three major spawning tributaries. These workers now believe that it will be possible to derive estimates of the relative abundance of each geographical subpopulation in samples taken from downstream mixing areas by analyzing their parasite complements.

International fishery problems concerning the rational exploitation of high-seas populations of sockeye (*O. nerka*) and pink (*O. gorbuschka*) salmon stimulated formation of the International North Pacific Fisheries Commission in 1953. Early sessions of this body established an artificial boundary line, sometimes called the temporary line of abstention, at the line of meridian 175° West Longitude, to separate the Asiatic (Japan) high-seas salmon fishery from the North American (Canada and the United States) for management and research. At the same time the participants undertook joint research to gather biological data on which a more realistic boundary line might be based. Subsequent researches strongly suggest that it will be possible to utilize differences between the species composition of the parasite faunas and the numerical incidence of various parasites occurring in high-seas populations of sockeye and pink salmon to distinguish their continental origins. According to the

parasitological data gathered to date the 1953 boundary line may not effect a biologically realistic separation of the two salmon stocks. For example, Margolis and other Canadian scientists (Jackson, 1957, 1958) who examined large numbers of sockeye and pink salmon from various high-seas and inshore stations from 1955 to 1957, reported that more than 50 species of parasites were encountered. Although the distribution of most of these parasites was not restricted, at least five of those found in sockeye salmon (four acquired in the sea, *Hemiurus levinseni,* a trematode, *Tubulovesicula lindbergi,* a trematode, *Echinorhynchus gadi,* an acanthocephalan, and *Anisakis* sp., a nematode; and one acquired in fresh-water—*Triaenophorus crassus,* a cestode) show promise of usefulness in separating high-seas salmon populations. There were also certain marked discontinuities in the distribution or abundance of three different marine parasites of pink salmon (*Hemiurus,* a trematode, *Bolbosoma,* an acanthocephalan and *Contracaecum,* a nematode) which seemed to indicate several main groups in the high-seas samples that could be related to coastal samples from Asiatic or North American inshore regions.

But helminths are not the only parasites useful as natural tags. After an intensive three year study of various parasites of sea herring (*Clupea harengus*) Sindermann (1957a and 1957b) concluded that the myxosporidian parasite (*Kudoa clupeidae*) should serve as a reliable "natural tag" during the first few years of the life of the host. His laboratory experiments and field observations indicated that the parasite apparently caused little mortality, a necessary attribute of a tag. In addition, the distribution pattern indicated by the relative incidence of this parasite in the different geographical host populations showed an, "absence of large-scale movements of sardine herring along the Maine coast, and a separation of such immature fish from eastern and western Maine, at least during the latter part of the first and much of the second year of life," (Sindermann, 1957b). The incidence of the other parasites encountered (the fungus, *Ichthyosporidium hoferi,* larval cestodes of the order Trypanorhyncha and the larval nematodes of the subfamily Anisakinae) confirmed these findings.

Parasites as Taxonomic Clues

Host specificity makes it possible to use parasitological data as auxiliary clues to the phylogenetic relationships of their hosts (Hargis, 1957). Recently Fish and Wildlife Service biologists in conjunction wth the Virginia Fisheries Laboratory have begun limited investigations into the possibility that certain parasitological data may be used to separate populations of Atlantic menhaden.

Parasites as Physiological Indicators

Often the life cycle of a parasite is so geared to that of its host that it serves as an indicator of the host's physiological condition. For example, juvenile nemerteans (*Carcinonemertes carcinophila*) encysted on the gills of the blue crab (*Callinectes sapidus*) are small and inconspicuous. After the female host has spawned the nemerteans excyst, migrate to her egg mass, grow and mature, lay eggs and return to the gills. It is possible to tell whether a host has spawned by the increased size and more noticeable color of the re-encysted gill parasites (Hopkins, 1947).

Parasites in Predator Control

Parasites and predators have been used to control certain undesirable

terrestrial populations. Similar applications have been considered for marine predators like the green crab (*Carcinides maenas*) and oyster drills (*Urosalpinx cinerea* and *Eupleura caudata*), so far without success. However, this possibility deserves further study.

Parasites and the Commercial Fishery

Parasites may have noteworthy adverse effects upon commercial fishery products. The presence of some of the diseases mentioned above, *e.g.*, "pepper-pot disease" of herring, etc., often necessitates culling of infected individuals. As Sindermann and Rosenfield (1954) pointed out, "several examples of decrease in desirability can be found in marine fishes . . . That certain diseases render the infected fish unacceptable as food is seen in fungus disease of herring. Canneries will not accept catches of herring with a high percentage of fungus infection, and excessive numbers of fungus spores in fish packed as sardines may be the cause for rejection of that particular pack by Food and Drug Inspection." Thus economic losses are suffered by the producer or the packer.

Most helminth parasites are eliminated in cleaning or immobilized in cooking and do not affect the marketability or edibility of the product. But some do adversely affect the preparation, marketing and consumption of fishery products. Certain infected fishes are often rejected by wholesalers or consumers because of the unsavory appearance of their wormy flesh.

The encysted flesh tapeworm (*Triaenophorus crassus*) is so unsightly that the Canadian Government regularly inspects whitefish (*Coregonus clupeaformis*) destined for commerce. As a result some Canadian producers have been forced to stop fishing for whitefish in heavily infested lakes. Others have begun to fillet, candle and trim their catches (Miller, 1952). Even so the U. S. Food and Drug Administration refused entry of 85 shipments totaling approximately 43,200 lbs. of infested whitefish during the period from June 1 to September 16, 1958. An additional 6,475 lbs. were seized at various places in this country (B. V. McFarland, personal communication).

For over twenty years northern seafood processors have been forced to candle certain fish, *e.g.*, redfish (*Sebastes marinus*), cod (*Gadus callarius*) and various flounders for flesh and skin parasites. According to personal communications from representatives of two such companies, unsightliness of parasitized fishes and U. S. Food and Drug Administration regulations demand that parasites be picked out or trimmed away before packaging. Their records indicate that candling and trimming cause an increase of up to 80 per cent in the cost of packaging. One company candles approximately 4,500,000 pounds of all commonly parasitized species per year. The parasites involved are: (1) "Buttons" in redfish (*Sphyrion lumpi,* a copepod); codworms (*Porocaecum decipiens,* a nematode); and (3) metacercarial cysts in flounder (*Stephanostomum hysterix,* a trematode). It is of interest to note that most parasitized fishes are caught in inshore areas. Fishes from deeper water seldom have parasites.

According to sport fishermen, Florida grouper fillets are often dewormed before cooking. The Virginia Fisheries Laboratory often receives inquiries from sport fishermen and other consumers concerning the edibility of parasitized fishes. Last summer we received several large preserved specimens of the clam nemertean, *Malacobdella grossa,* from the Virginia Department of Health with an inquiry concerning the edibility of parasitized *Mercenaria.*

Parasites are not always entirely detrimental, however, for the pea crab (*Pinnotheres ostreum*) which probably adversely effects oysters, is considered a delicacy by some and was once commonly packaged for market but the practice is declining. Nowadays shuckers seldom go to the trouble of recovering crabs and the appetites of some seafood gourmets go unsatisfied.

Parasites definitely affect all phases of fishery operations, production, preparation, marketing and research. Many of their effects remain to be assessed. Undoubtedly, fishery science must pay increased attention to them, not only because they are commercially important but also because they have potential value as research tools.

LITERATURE CITED

Andrews, J. D. and W. G. Hewatt.
1957. Oyster mortality studies in Virginia. II. The fungus disease caused by *Dermocystidium marinum* in oysters of Chesapeake Bay. Ecol. Monogr., 27: 1-26.

Hargis, W. J., Jr.
1957. The host specificity of monogenetic trematodes. Exper. Parasitol. 6; 610-625.

Hopkins, S. H.
1947. The nemertean *Carcinonemertes* as an indicator of the spawning history of the host, *Callinectes sapidus*. J. Parasitol. 33: 146-150.

Jackson, R. I.
1957. The research program of the North Pacific Fisheries Commission. A. Compilation of research summaries for 1956. Research by Canada. Ann. Rept. Internat. N. Pacific Fish. Comm. for 1956: 29-49.
1958. The research program of the North Pacific Fisheries Commission. A. Progress in 1957 in Canadian Research on problems raised by Protocol. Ann. Rept. Internat. N. Pacific Fish. Comm. for 1957: 23-38.

Mackin, J. G., H. M. Owen and A. Collier.
1950. Preliminary notes on the occurrence of a new protistan parasite, *Dermocystidium marinum*, n. sp. in *Crassostrea virginica* (Gmelin). Science 111: 328-329.

Miller, R. B.
1952. A review of the *Triaenophorus* problem in Canadian lakes. J. Fishery Res. Bd. of Canada, Bull. No. 95: 1-41.

Ray, S. M.
1953. Studies on the occurrence of *Dermocystidium marinum* in young oysters. Mimeo. Rept: 1-16.

Sindermann, C. J. and A. Rosenfield
1954. Diseases of fishes of the Western North Atlantic I. Diseases of the sea herring (*Clupea harengus*). Res. Bull. No. 18, Maine Dept. of Sea and Shore Fisheries: 1-16.

Sindermann, C. J.
1956. Diseases of fishes of the Western North Atlantic IV. Fungus diseases and resultant mortalities of herring in the Gulf of St. Lawrence in 1955. Res. Bull. No. 25, Maine Dept. of Sea and Shore Fisheries: 1-23.

1957a. Diseases of fishes of Western North Atlantic V. Parasites as indicators of herring movements. Res. Bull. No. 27, Maine Dept. of Sea and Shore Fisheries: 1-30.

1957b. Diseases of fishes of the Western North Atlantic VI. Geographic discontinuity of myxosporidiosis in immature herring from the Gulf of Maine. Res. Bull. No. 29, Maine Dept. of Sea and Shore Fisheries: 1-20.

Uzmann, J. R., R. H. Lansen and M. N. Hesselholt
1957. Parasitological methods for identification and abundance estimates of downstream migrant races of salmon. Unpublished address presented before the Eighth Alaskan Science Conference at Anchorage: 1-7.

Walford, L. A.
1958. Living resources of the sea. Opportunities for research and expansion Ronald Press, N. Y.: xi+321 pp.

A New Fishery For Scallops in Western Florida

Harvey R. Bullis, Jr.
U. S. Fish and Wildlife Service
and
Robert M. Ingle
Florida State Board of Conservation

The Gulf scallop, *Pecten (Aequipecten) gibbus,* has at last entered the commercial picture. For decades, shell collectors roaming the west coast of Florida have commented on the vast heaps of this species washed ashore by stormy seas, particularly in the Marco and Sanibel Island areas, and it has become a cliché to comment about "commercial possibilities of harvesting" this species. Even with periodic knee-deep windrows of fresh shell lined up on the beaches, no serious consideration was given to commercial investigation.

With the consumer acceptance of grooved shrimp, which occurred in the late 1940's, and the discovery and opening of the Dry Tortugas shrimp grounds in late 1949 and early 1950, an effective scallop catching gear, the shrimp trawl, was introduced to this general area for the first time. Several species of scallops were found within the relatively narrow confines of the early Tortugas fishery and these momentarily excited some interest; however, as the shrimp fishing areas were more closely delineated, and shallower water exploratory probing with try-nets lessened, scallop reports decreased and the fleet limited itself to catching shrimp.

The first active exploration for commercial concentrations of the Gulf scallop was carried out in April, 1954, in conjunction with some "bad bottom" exploratory shrimp trawling conducted by the Fish and Wildlife Service exploratory fishing vessel, *Oregon,* off the southwestern coast of Florida. An examination of earlier *Oregon* shrimp trawling records (January, 1951) in this area revealed that *P. gibbus* was extensively distributed out to depths of twenty-five fathoms and that catches as high as two bushels of two inch scallops were made between five and ten fathoms off Naples. During *Oregon* Cruise No. 22, some

nineteen drags were made with a modified Biloxi-type oyster dredge, chiefly in the exact locations of previous scallop catches. The catches were now completely devoid of living scallops and test dragging with forty-foot shrimp trawls were equally ineffective. It was apparent that either the population in this area had moved or had died out.

By 1955, several small shrimp fishing areas with periodic production had been located north of the Tortugas grounds by individual vessels. In July and August, the Tampa Shrimp Producers Association, operating the trawler *Goodwill,* which had been loaned to them by Diesel Engine Sales Corporation, explored the area north of the Middle Grounds as far as Cape San Blas. Several try-net drags south of Cape St. George caught *P. gibbus* in depths of twenty-five to fifty fathoms. The size and numbers of scallops indicated an extensive bed running between the offings of Cape San Blas and Cape St. George. This information was contained in a cruise report issued by the University of Miami Marine Laboratory, which had provided a biological observer for the work.

In the fall of 1955, Captain Charles Kaufmann investigated the ten to thirty fathom area off Panama City and Apalachicola as a possible source for scrap fish. Working with the vessel *Debbie K.,* he found several areas of heavy Gulf scallop concentrations and virtually had to abandon trawling in some places. He reported catches of up to twenty bushels of scallops per fifteen minute tow. To his credit, he brought a catch of about twenty-five bushels into Panama City to see if they could be shucked and sold locally. The local facilities were apparently not capable of handling the catch, and it was dumped at sea.

In response to several requests for more information, and to the particular urging of Tom Wells of E. E. Saunders Co., Pensacola, a part of *Oregon* Cruise No. 43, in February, 1957, was spent making some fifty-four scallop dredge tows between Pensacola and Cape St. George. In July, 1957, the chartered exploratory fishing vessel *Silver Bay* continued the work with about thirty drags between Cape San Blas and Cape St. George. The gear used for this work was an eight-foot "Georges Bank" type sea scallop dredge, but constructed of two inch rings. Catches ranged up to six bushels per half hour drag, but it was subsequently discovered that eighty to ninety per cent of the scallop catch was being lost through the spaces "between" the rings. Comparative drags with this gear using a two inch stretched mesh liner conducted this summer showed capacity catches (about forty bushels) per fifteen minute tow.

To supplement the rather uncertain bay scallop (*Pecten* (*Aequipecten*) *irradians concentricus)* supply and to allow for a longer period of production each year, Mr. J. D. Holmes of the Holmes Fish Company, Panama City, began small scale exploratory fishing offshore early in 1956. Monthly trips were made to locate scallops, and observe the size and development of the individuals encountered.

During the winter of 1957-58, rather dense populations were found by running south southeast of St. Andrews Bay, a distance of approximately twenty-five miles. This bed, undoubtedly the same as originally located by Kaufmann, was found to extend from a point three miles west of St. Joe Buoy to south of St. Andrews Bay Old Pass. These bottoms lay in 40 to 120 feet of water and covered an area five to ten miles wide and ten miles long.

Although heavy concentrations of scallops were encountered, the scallops were not large enough for exploitation until February, 1958. In March of 1958,

two boats started to work the grounds. This was expanded to four boats during the first part of April.

The vessels, which operated during March, 1958, were about forty-five feet long, cruised at ten miles per hour and carried a crew of three men. On a typical trip, the boat left the dock about 3:00 a.m. and arrived on the grounds in about three hours. Scallops were caught for about five hours, after which the return trip was made. The catch was usually unloaded about midafternoon of the day the trip was made.

Scallops were first captured by shrimp trawls and later by dragging a four foot wide dredge with a bag six feet long.

An average production was 150 baskets per trip, the baskets being wire mesh tubs that are standard equipment of most Florida wholesalers for handling and weighing fish and shellfish.

One tub of unshucked scallops (about 500) would yield about five pounds of meats. A gallon of meats could be produced from one and three-fifths tubs. Accordingly, the average trips would net about ninety-three gallons of meats.

The yield was not steady throughout the season. In February, 130-140 were needed to produce a pound of meat, whereas in March and April, 100 unshucked scallops yielded a pound of meat. It has also been noted that no effort at size grading was made, at least early in the commercial development. Most of the lots we have examined have contained meats varying in size from about one-half inch to one inch in diameter. Size uniformity which could easily be attained by the use of grading screens would undoubtedly provide a more attractive pack and might provide some beneficial sales promotion features.

Yield began to dip again in August and by September, fishing was considered no longer profitable. The decline in amount of meat per animal appears to be related to spawning. During the spring when yield is highest, gonads are highly developed. Later in the summer, presumably after spawning, the animals become moribund and the muscle is only weakly attached to the valves.

Production of 1,200-2,000 gallons per week, which was attained by Holmes, gives little information concerning the amount that might be realized. During the period of development of the fishery the price per gallon for scallop meats was extremely low nationally. This made enlargement of the Panama City fishery unattractive and no additional boats joined the original four.

The fishermen working the new beds state that scallops were in great abundance and production could have been several times what it was. The poor market price made the operation unprofitable.

An experimental scallop fishing operation was tried from Apalachicola during late spring and summer of this year. The grounds worked were those first noted by the *Silver Bay* and represent the inner limits of the area found by the *Goodwill,* which lie off Cape San Blas in fifteen to sixteen fathoms. Due to the poor market condition, the operation stopped. No production data is available on this venture.

There is considerable conviction among the Gulf scallop fishermen that few individuals of the fished stocks survive until late fall, and they propose a short life expectancy as has been previously noted in the case of the bay scallop (Murdock, 1955). The random samples measured during the *Oregon* and *Silver Bay* work are insufficient for definite growth determination, due primarily to the time factors involved, but the samples do not agree with the conclusions reached by the commercial fishermen. Maximum shell diameter meas-

urements show two well delineated size groups that very probably represent year classes. These samples contained from 744 to 2,109 measurements. Several variables are present in these data, chiefly, that they are from several different areas within the so-called grounds, and that the original exploratory gear (without the liner) undoubtedly had some size selectivity. However, the size frequency peaks are well defined and well separated and tentatively indicate that growth proceeds at approximately one inch per year. In July, the one year olds are at approximately 20-22 mm and preponderately range from 15-25 mm. At twenty months they range from 23 to 32 mm and average 28 mm. At twenty-four months they range from about 46 to 64 mm and average about 54 mm. The data show little appreciable change between twenty-four and thirty-two months. However, at thirty-six months the range is about 65 to 76 mm and averages about 70 mm. Other exploratory data strongly indicates shifting of population "centers" and the moving of year classes could well create the picture as outlined by the fishermen. On the other hand, the picture presented by the inadequate size frequency data now at hand should not be given too much importance. The material for growth studies is available at Panama City and some priority should be given to obtaining this important and useful information.

There is also some question concerning the taxonomy of *P. gibbus*. In the past the variations in certain shell characteristics have been considered subspecific by some workers, and merely ecological variations by others. In its various "forms," the species is known to range from North Carolina to the northeastern coast of South America. It is not too surprising, therefore, to note that these newly worked grounds off Cape San Blas are stocked with a "form" which might be considered atypical from the better known areas of Marco and Sanibel Islands.

What is the future of this fishery? We do not know any of the factors of abundance, or what cyclic movements may occur. However, at this time the prospects are good that it will undergo some expansion and eventually provide a substantial part of the state's scallop production. The limited fishing has not approached the production potential. The recent surveys show the present grounds to extend beyond the areas so far fished, with heavy crops of young scallops now present.

REFERENCES

ANON.

1958. Gulf of Mexico explored for hand clams and scallops *(M/V Silver Bay* Cruise 10). Comm. Fish. Rev., 20 (9): 41-43.

MURDOCK, JAMES

1955. Investigations of the Lee County Bay Scallop Fishery, Report to the Florida State Board of Conservation, University of Miami Marine Laboratory, mimeo.

Improved Techniques For Collecting Seed Oysters in the Chesapeake Area

David H. Wallace
Oyster Institute of North America
Annapolis, Md.

The foundation of successful commercial oyster culture is an adequate source of seed oysters. Seed is as important for oyster farming as it is for wheat growers in the Midwest or the rice farmers of Japan. Where harvesting of a wild crop is the normal procedure, either on land or on an oyster bed, the average yield is far lower than in areas where cultivation of the crop is the practice.

Seed areas are the most valuable oyster grounds of all and are proportionately scarce; bottoms for growing are far more extensive and a greater variety of conditions can be tolerated. Biologists and commercial oyster farmers alike have tried, from time to time, to describe precisely the environment necessary for successful spawning, fertilization of the eggs, growth and survival of the larvae, and final setting and survival of the spat. So far no one has been able to specify these conditions which would apply in all parts of the range of our eastern oyster. Possibly this is because we do not observe closely enough.

Lunz found that with proper arrangements he could encourage young oysters to set in great abundance in the warm, muddy waters of South Carolina rivers. The encouragement was provided in the form of shell bags suspended on a wire between two pilings in the zone between high and low tide. His oysters succeeded where others failed to set on shells on the bottom. He concluded that silt collected on the bottom and rendered the shells there unable to receive a set. When shells were suspended above the bottom in the tidal zone the silt seemed to be carried away, leaving a clean surface for attachment of the spat.

Lunz is not the only scientist who has encouraged setting by removing the shells from the bottom. For many years the Japanese have been punching holes in oyster shells, stringing them on wire, and suspending them in the water just before setting. The technique was adopted in the Pacific Northwest with some success, but the oystermen there found they could import cheaper, better seed from Japan than they could grow themselves.

In British Columbia where the waters are very deep and with little intertidal zone, Quayle developed floating rafts, with strings of shells suspended beneath them. His experiments were most successful in obtaining a set, and furthermore the young oysters grew far more rapidly when raised off the bottom.

Various other commercial practices have been developed in various parts of the world to collect seed. In Australia, hickory sticks are placed on racks just prior to setting. The spat are then shaved off the sticks for planting on the growing grounds. In Holland, the Dutch use smooth tiles as cultch and the spat are scraped off when they have become hard enough to withstand such treatment.

Along the Atlantic and Gulf Coasts collection of seed has been more haphazard. While a great variety of setting experiments have been carried out, the oystermen have generally ruled out new techniques without testing them, on the grounds they were impractical. The commercial practice is to throw shells on the bottom sometime in the spring or early summer and hope for the

best. In many areas oystermen make no attempt to grow seed. Their seed stock is obtained from public grounds, where it grows naturally. This is a condition fast disappearing, since the natural seed rocks become depleted and apparently unable to replenish themselves each year. The public seed grounds in Connecticut are excellent examples. Where 1,000 tongers worked twenty-five years ago taking seed, not a single license was issued last year for the Bridgeport, Conn., natural area which contains thousands of acres.

Along the Atlantic Coast the only natural seed produced in abundance without assistance from man is from the James River in Virginia. The natural beds there are undoubtedly the most extensive, finest natural seed grounds in the world. From 2.5 to 3.5 millions of seed are produced each year, with no indications at present of overfishing.

In New Jersey the natural seed beds in the upper Delaware Bay are badly depleted. The oyster planters there are seeking other seed sources. In Maryland, natural seed is unavailable to the private planters, and even in Virginia, where the oyster growers are blessed with a good supply, efforts are being made to plant shells for the purpose of obtaining a set, to hedge against set failures in the James River.

Planting of shells for cultch is widely practiced throughout the range of the eastern oysters but the techniques for doing this are almost as numerous as the persons engaged in it. Neither time nor interest permit a description of each. Except for plantings by the state of Maryland on the public grounds, shells are planted as near to the time of setting as is possible from a mechanical standpoint. Dependent upon the type of bottom and tidal conditions, the shells are either strewn over the bottom broadcast, placed in small humps or in windrows. Concentrations vary from 2,000 to 10,000 bushels per acre, dependent again upon the bottom and the method of planting. In Maryland, shells are planted in areas where experience or sampling indicate a reasonable expectancy of a good set. Planting is not done by an indiscriminate scattering of shells during all parts of the year, as done by some states.

Even under these controlled conditions, results have been variable from year to year in the Chesapeake area. Even in high setting years the yield of seed is usually less than two-thirds the amount of shell planted, and there is great variation in quality of the seed when it is transplanted.

Two years ago biologists of the Fish and Wildlife Service carried out experiments in an area called Smith's Creek in Maryland where much of the bottom is leased and is being used to grow seed. They suspended small shell bags at various depths in the water from the surface to the bottom. Shells were also planted on the bottom under the structures built to hold the bags. It is not my prerogative to detail their results, but the general findings were made available to the planters in the area. To those interested in seed culture, the conclusions were startling. Setting in the area was best from just above the bottom and to about two feet above it, where the overall depths of the water were about six feet. The surface set was poor in comparison.

The bags just above the bottom had a very high count of surviving oysters at the end of three months. For the practical oyster farmer the conclusions were disturbing indeed. How could a practical planting operation collect set zero to two feet above the bottom in waters ranging in depths from five to ten feet?

During the summer of 1958, a large scale planting was carried out in Smith's Creek which attempted to meet the setting characteristics of the area as indi-

cated by the experimental studies. Shell bags were constructed of one inch chicken wire. The bags were approximately twenty-four inches high by twenty inches wide, and when filled with shells were about ten inches thick. A slightly wider and thicker bag was also made and used for comparative purposes, holding three-fourths of a bushel of shells.

Rather than suspend the bags from a sagging cable, which seemed impractical on a large scale, or to drop them over individually so they would be lying on the bottom, three of the filled bags were tied together. When the group of three was dropped overboard, they sank to the bottom, coming to rest in an upright position, in a sort of tripod arrangement. This placed them in the heavy setting zone, with the maximum shell surface exposed for a set. Since set have been known to penetrate six inches into a pile of shells, there was reason to believe the inner shells might receive a set.

This planting was not on an experimental basis. Almost 30,000 bags of shells were placed over in this manner. In the same area, and even adjacent to the bags, other oystermen planted large quantities of shells in the orthodox manner.

Undoubtedly 1958 will be recorded as a poor setting year in Chesapeake Bay. Every report of the biologists working on the Bay indicates light or no sets, except in the James River. Smith's Creek was no exception. The set there was probably the lightest in the last five years. From preliminary examination, a large percentage of the shells planted on the bottom probably do not have a set sufficiently good to justify moving. Some samples examined counted less than 250 young oysters per bushel of shell. The results were quite different on the bags. The set in these ranged from 250 to more than 1,500 per bushel. Furthermore, the spat grew far more rapidly than those on the bottom. Survival after three months was high, and after three months the planting was moved since the young oysters had begun to grow through the meshes of the bag.

This method is far more costly than meets the eye. It usually ends in large quantities of the material being lost as a base for attachment of the larvae, and a poorer count of seed for planting. While the actual processes were far more expensive than the conventional planting, the results in a commercial set justified the procedure. In my opinion, had 1958 been a high setting year the values would have been just as striking in favor of the bag plantings.

This one planting is being detailed to illustrate the possibilities of utilizing local conditions to the advantage of the grower. It is not presented to be the panacea for seed culture in the United States. In fact it is almost certain that such a technique would be an utter failure in South Carolina or possibly in Georgia. However, it is my firm conviction that the production of seed has to move beyond the rudimentary stage of wholesale throwing over of cultch on the bottom in hopes a great quantity of oysters will attach themselves there.

The oyster industry must improve its methods and approach maximum efficiency if it expects to compete in the present food market. Oyster production in the United States is declining even as our population is growing by leaps and bounds. We are getting less and less of the consumer dollar spent for food, because of our inability to produce in sufficient quantities to justify selling our product.

The production of oysters lends itself better to a fusion of science and industry than any of the fishery products produced in the United States. We need new thinking, new ideas and good technical advice. In the states where private

growers are permitted to operate, the services of biologists should be available to them for guidance. Experiments should be planned and developed to supply some answers to their questions. In the states where public oystering is the policy, biologists and business men should team up to provide sound management divorced as far as possible from political pressures. I emphasize the combination of biologists and business men since my own experience indicates that biologists as managers are frequently quite impractical and need the assistance which good business men can give.

Oysters are cooperative subjects to work with. They spawn and the larvae set consistently if given half a chance. I am confident that every state along the Atlantic and Gulf Coasts could greatly increase its supply of oysters, if we could obtain the close liaison between science and industry. The Gulf and Caribbean Fisheries Institute can be a major factor in bringing this about.

Progress in Atlantic Coast Shad Investigations—Migration

James E. Sykes and Gerald B. Talbot
U. S. Fish & Wildlife Service
Beaufort, North Carolina

In 1950, at the request of the Atlantic States Marine Fisheries Commission, the U. S. Fish and Wildlife Service began a study of the Atlantic Coast shad (*Alosa sapidissima*). This project was undertaken to determine causes of fluctuations in abundance of this species and methods of controlling and predicting the size of shad runs. We were remarkably successful in achieving these objectives for rivers where records of the shad catch each year and the amount of gear used each year in making that catch were available (Fredin 1954; Talbot 1954).

Much of the research depended upon estimation of the total populations of shad in the rivers being studied. The estimates were determined through tagging programs in which ratios of tagged to untagged fish sampled in catches were applied to total numbers of fish tagged so that total numbers of fish in the populations were derived. Usually between 40 and 50 per cent of the tags applied were recovered within the river of tagging. Some of those tagged fish which were not caught in the rivers and which escaped other mortalities were recaptured elsewhere, and from these, as well as recaptures from other tagging experiments, the oceanic migration pattern of shad became known.

The shad is an anadromous fish, running up coastal rivers to spawn. Its river life is rather well known. Shad begin running into the St. Johns River in Florida (which is the southern range of this species) as early as November. The runs begin in more northern streams at progressively later dates. For instance, shad enter Chesapeake Bay streams in February and March, the Hudson River in April, and the St. Lawrence River (the northern limit of the species) in June. While in the river, the females deposit an average of about 250,000 eggs. These are deposited loosely in the water and are then fertilized by the males. After absorbing water, the fertilized eggs sink to the bottom and are carried along by the current. The eggs hatch in three to ten days, depending upon

water temperature. The young shad stay in the rivers until fall and when they are three to five inches in length they migrate to the sea. After spawning, the adults, if they escape fishing and natural mortalities, migrate to sea. Where they go after leaving the rivers and where the young remain until they return as

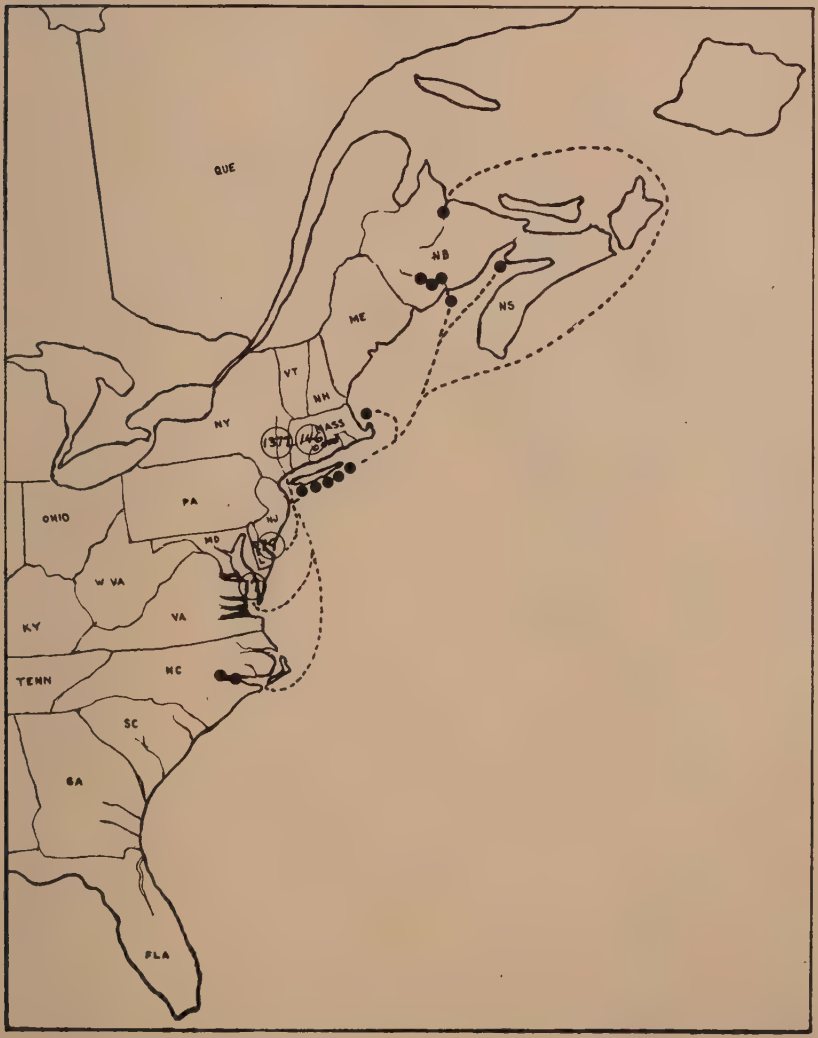

FIGURE 1. Tags recovered before or during the spawning period from tags affixed at Fire Island, Staten Island and the New Jersey Coast. Black dots indicate one tag recovery whereas numbers in circles indicate a larger number of recoveries.

adults, has always been a mystery and the subject of several hypotheses.

It was originally thought because these fish were first seen each year in the

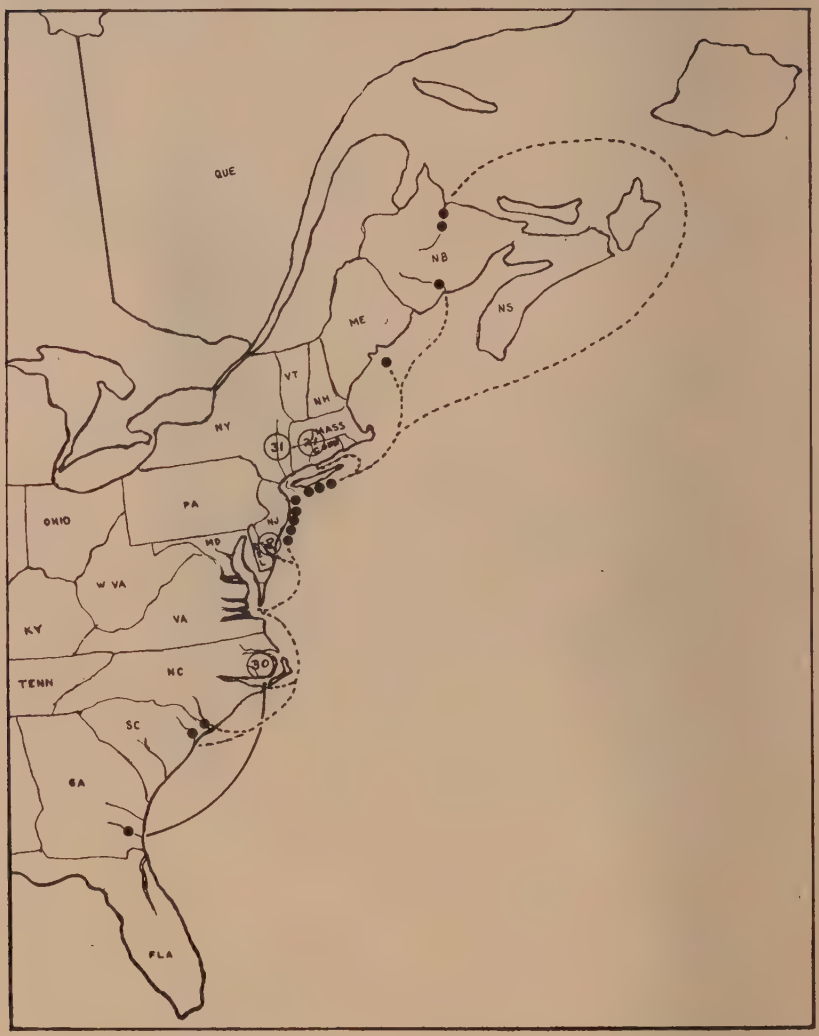

FIGURE 2. Tags recovered before or during spawning from tags affixed in Chesapeake Bay and tributaries and from tags affixed at the mouth of the Neuse River in North Carolina. Black dots represent one recapture and numbers in circles indicate a larger number of recoveries. The dashed line indicates migration of Chesapeake Bay tagged shad while the solid line indicates migration of shad tagged at the mouth of the Neuse River.

south, that they wintered there and started northward each spring in a vast school, sending detachments into each successive stream as they passed, the last of them entering the St. Lawrence River. A later theory was that the adults, and later the young, moved out of the rivers and remained in the ocean near the mouths of the rivers where they were born and entered the rivers again when the water temperature became suitable. Tag returns, however, have shown

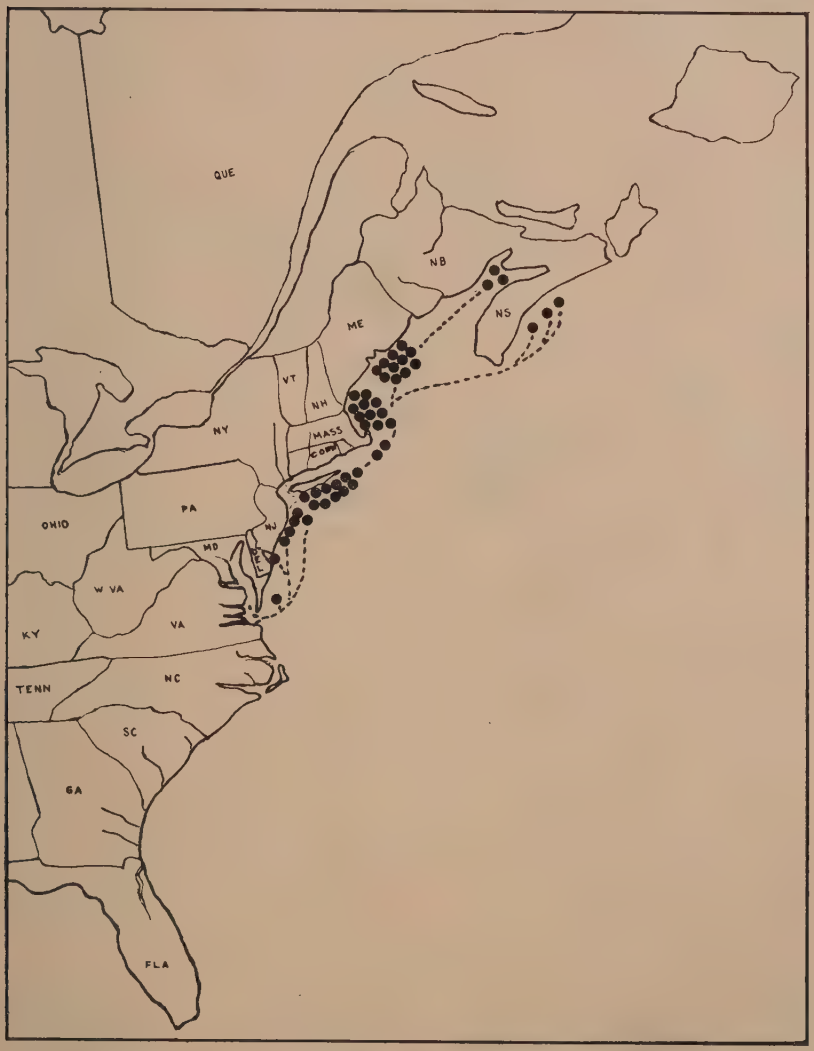

FIGURE 3. Tags recovered after the spawning period from all spring tagging programs.

that shad undertake a regular migration pattern each year which does not bear out either of these hypotheses.

The returns from a total of 17,508 tags applied to shad at many locations along the Atlantic Coast between 1938 and 1955 were used in this study. A total of 6,846 tags, or 39 per cent, of these were recovered.

Most of the tagging was carried out in the spring of the year during the

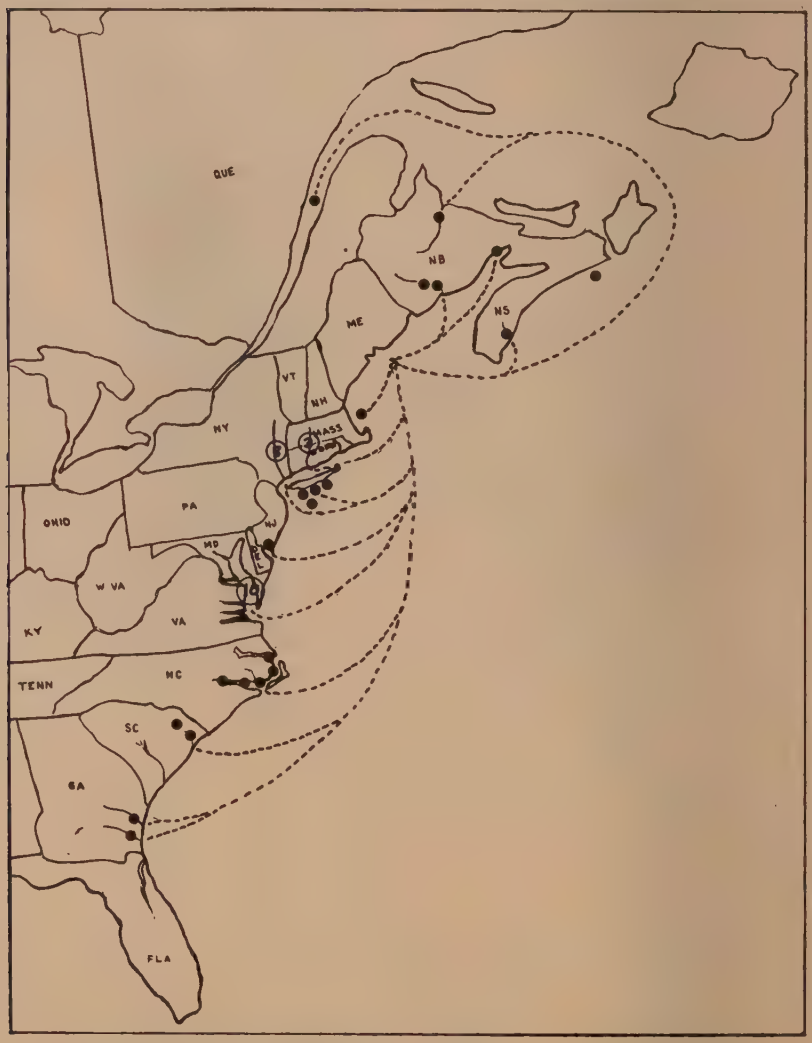

FIGURE 4. Tags recovered from tags affixed in the Gulf of Maine during the summer.

spawning run, but some were tagged off the coast of Maine during the summer months. Table 1 shows the locations where shad were tagged, the number tagged, and the number recovered. For the purpose of analyzing the tag returns from the spring tagging projects, they were separated into two categories. These are:

1. Recoveries made before or during the spawning period.
2. Recoveries after spawning.

The above separation was based on a knowledge of the spawning periods in each of the rivers. The date, May 31, was arbitrarily chosen as the latest that shad would be spawning south of Long Island and June 14 north of Long Island. The shad tagged in the Gulf of Maine were analyzed in a third category.

Figure 1 shows the pattern of migration of shad tagged at Fire Island and Staten Island, New York, and the New Jersey coast from March through June and recovered before or during the spawning period. The bulk of the shad caught and tagged in this area were heading for the Hudson River where 1,377 returns were made and to the Connecticut River where 146 were recaptured. Some, however, were recaptured south of New Jersey—nineteen in Delaware Bay and tributaries, seventeen in Chesapeake Bay and tributaries, two in North Carolina waters, and several north of New Jersey as far as the Bay of Fundy and Mirimichi River in Canada.

Figure 2 shows the recoveries of shad tagged in the spring in Chesapeake Bay and recaptured elsewhere before June 1. Those recovered in Chesapeake Bay and tributaries were of course in the majority—some 1,700—but are not shown since they show no migration. Those migrating out of the Bay and recaptured before or during spawning were recovered in the ocean and streams from South Carolina to New Brunswick, Canada. Also shown in this figure is the migration of a shad tagged at the mouth of the Neuse River, North Carolina, and recovered in the Altamaha River in Georgia. Here too, the bulk of the Neuse River tagged fish were recaptured in the river of tagging.

TABLE 1

SHAD TAGGED AND TAGS RECOVERED

Place tagged	No. tagged	No. recovered
Gulf of Maine	601	44
Connecticut River	2,542	612
Fire Island, New York	198	49
Staten Island, New York	1,054	478
Hudson River	3,295	1,321
New Jersey Coast	3,421	1,263
Chesapeake Bay and tributaries	4,775	2,514
Neuse River, North Carolina	377	226
Edisto River, South Carolina	128	16
Ogeechee River, Georgia	235	133
St. Johns River, Florida	882	190
Totals	17,508	6,846

The tag recoveries shown in these two figures indicate that, in general, most of the shad caught in the spring of the year at each location are heading toward the nearest spawning streams in the area, but with them are shad bound for other places along almost the entire range of the species.

Figure 3 shows recoveries from all tagging programs made after the spawning period—that is, after May 31 at Long Island and southward, and after June 14 north of Long Island. All recaptures were made north of the tagging sites from shad which were either in the Gulf of Maine or apparently on their way there. The recaptures near Long Island were made between June 5 and 26. Those captured off Massachusetts were made between June 22 and November 3, but none was recaptured during September. In Maine and Canadian waters the recoveries were made only during July, August, and September. This indicates that shad are caught during June, July, and August as they migrate past Massachusetts on their way north into the Gulf of Maine region, and again during October and November on a southern migration. Vladykov (1950, 1957) has reported that shad tagged in the St. Lawrence River during the spawning run also migrated to the Gulf of Maine during July and August. Not a single tag affixed to shad in streams south of the Chesapeake Bay area was recovered after the spawning period.

Recoveries of tags affixed in the Gulf of Maine are shown in Figure 4. These were tagged during August and September, and all recoveries were made the following spring except the one in Massachusetts which was recaptured in the fall approximately two months after tagging. As can be seen, shad tagged in the Gulf of Maine area were later recaptured throughout the entire range of the species except for the St. Johns River in Florida. Since the number of fish tagged was small and the recapture spread along the entire coast, we believe the lack of recaptures in the St. Johns River is probably the result of chance rather than an exception to the general pattern.

Since none of the adult shad tagged in streams south of Chesapeake Bay was ever recovered outside the rivers, the shad tagged in Maine which entered the southern rivers must have been immature when tagged. This leads to the conclusion that young shad migrate to the Gulf of Maine for the summer as well as adult fish. Atkins (1887) and Bigelow and Welsh (1925) reported large numbers of both large and small shad in the Gulf of Maine, but these writers at the time thought they were shad from Maine streams. In recent years, however, there have been few shad in Maine streams because of dams and pollution (Taylor, 1951), but still large numbers of shad are found in the Gulf of Maine each year. The migration to this area by shad from all other Atlantic Coast shad streams undoubtedly accounts for the large numbers found in the Gulf of Maine during the summer months.

Not much is known about where these fish spend the winter months since only one tag has been recovered during December and January. This was recovered in the ocean off New Jersey. Shad appear in abundance, however, along the middle and south Atlantic Coasts beginning in February, and it is assumed that they spend the winter here, probably in deep water. Some evidence of this was found when shad were caught in forty to fifty fathoms of water off North Carolina in March, 1958 by the U. S. Fish and Wildlife Service vessel, *Delaware*. When shad appeared in abundance along the middle and south Atlantic Coast, tagged shad from all areas were with them. For instance, shad tagged in the St. Lawrence River by Vladykov were recovered the following spring as far south as Chesapeake Bay, and those tagged on the spawning grounds of the Hudson River were recovered the following spring as far south as North Carolina. However, 185 Hudson-tagged fish returned to the Hudson, and twenty-three Connecticut-tagged shad returned to the Connecticut, but not

a single tag was found on the spawning grounds of any other stream. This indicates that although shad may migrate many hundreds of miles in the ocean, they return to the same stream to spawn the following year.

Considerable evidence is available to show that shad return to their native stream to spawn. Hollis (1948) and Coker inserted small plastic tags into the belly cavities of juvenile shad. These were released in two areas—one in North Carolina and the other in Maryland. In each case the few returns received three, four, and five years later from mature adult shad came from the area of release or from fish that could have been on their way there. None was returned from an area that would indicate that they might spawn in any place but their "home" stream.

Further, Hammer (1942) made a study of the scales and measurements of shad from tributaries of Chesapeake Bay and found significant differences in shad from various streams, indicating separate populations that return to spawn in the stream of their origin.

As previously noted, shad tagged in rivers south of Chesapeake Bay are never recovered after the spawning period. An examination of the scales from these fish shows that they are spawning for the first time, and hence it can be assumed that they die after spawning. Scales from shad spawning in the more northern streams show that 27 to 50 per cent of the fish are spawning for the second or more times. This is good evidence that few, if any, shad of the northern populations stray into and spawn in the southern streams.

It has also been shown (Fredin 1954; Talbot 1954) for some shad streams that the size of run in each stream is dependent upon the number of shad previously spawning. In other words, each of the runs in a shad stream is self-perpetuating and fluctuates independently of shad runs in other streams. This could only occur if the majority of the shad return to their home stream. The available evidence, therefore, indicates that most shad do return to their native stream to spawn.

From the data presented, we can summarize the migration pattern of Atlantic Coast shad. After spawning, adult shad in streams from Chesapeake Bay and northward migrate to the Gulf of Maine and spend the summer and fall there. Little evidence is available as to where they spend the winter months, but it is presumed that this period is spent in deep water in the middle and south Atlantic area. Beginning in January or February as the spawning season approaches, shad move inshore, and some are taken by the coastal commercial fisheries. They then migrate either north or south to their native streams and spawn, repeating this cycle if they escape natural and fishing mortalities. The young shad leave their native streams in the fall; probably spend the winters in the middle Atlantic area; migrate to the Gulf of Maine each summer along with the adults; and when mature, return to their native streams to spawn. Those that spawn in streams south of Chesapeake Bay, and particularly south of North Carolina, die after spawning.

Knowledge concerning the migration of this fish is not only interesting from a life-history standpoint, but is also useful in the management of the species. In our investigations we have shown that over 80 per cent of the variations in size of populations studied can be accounted for by changes in size of the spawning populations in previous years. The balance of changes can be attributed, partly at least, to variations in the catches outside the rivers. Shad are not fished extensively in the Gulf of Maine because only the female shad bring good prices,

and almost all of the shad in the Gulf of Maine are either immature or spawned out. However, during the last war when fish prices were high, over a million pounds were landed. Again in 1957, fishermen in the Gulf of Maine turned to shad when menhaden failed to appear, and over two million pounds of shad were landed during the summer months. Landing figures of all shad catches outside the usual fishing sites, now that we know the migration pattern, should enable us to better our control of population size and to make even better predictions of abundance than we have previously been able to do.

LITERATURE CITED

Atkins, C. G.
1887. The river fisheries of Maine. *In* Goode, G. Brown and associates, the Fisheries and Fishery Industries of the United States, Sect. 5, vol. 1, 808 pp.

Bigelow, Henry B., and William W. Welsh
1925. Fishes of the Gulf of Maine. U. S. Bureau of Fisheries, Bull., vol. 40 (1924), Pt. 1, 567 pp.

Fredin, Reynold A.
1954. Causes of fluctuations in abundance of Connecticut River shad. U. S. Fish and Wildlife Service, Fishery Bull., vol. 54, No. 88, pp. 247-259.

Hammer, Ralph Curtis
1942. The homing instinct of the Chesapeake Bay shad *(Alosa sapidissima,* Wilson) as revealed by a study of their scales. Thesis, University of Maryland, 45 pp. (Typewritten).

Hollis, E. H.
1948. The homing tendency of shad. Science, vol. 108, No. 2804, pp. 332-333.

Talbot, Gerald B.
1954. Factors associated with fluctuations in abundance of Hudson River shad. U. S. Fish and Wildlife Service, Fishery Bull., vol. 56, No. 101, pp. 373-413.

Taylor, Clyde C.
1951. A survey of former shad streams in Maine. U. S. Fish & Wildlife Service, Special Scientific Rept.: Fisheries No. 66, 29 pp.

Vladykov, Vadim D.
1950. Movements of Quebec shad *(Alosa sapidissima)* as demonstrated by tagging. Naturaliste Canadien, vol. 77, Nos. 5-6, pp. 121-135.
1957. Distant recaptures of shad *(Alosa sapidissima)* tagged in Quebec. Naturaliste Canadien, vol. 83, No. 10, pp. 235-248.

Techniques Used in the Tagging of Yellowfin and Skipjack Tunas in the Eastern Tropical Pacific Ocean During 1955-1957

GORDON C. BROADHEAD
Inter-American Tropical Tuna Commission
La Jolla, Calif.

INTRODUCTION

THE INTER-AMERICAN TROPICAL TUNA COMMISSION is charged with the maintenance of the populations of tropical tunas and tuna bait-fishes in the Eastern Tropical Pacific Ocean at levels which will permit maximum sustained catches year after year. The fishery for tropical tunas ranges from Southern California to northern Chile and offshore to a distance of several hundred miles, a sea surface area of about one and one-quarter million square miles. From this vast area some 300 million pounds of yellowfin tuna, *Neothunnus macropterus,* and skipjack, *Katsuwonus pelamis,* are taken each year, in approximately equal amounts by species during recent years. Over 95 per cent of this catch is landed in the United States or transhipped there from foreign ports. The present fishing fleet consists of about 165 long-range live-bait clippers and 45 large purse-seine vessels. This fleet operates from San Diego and San Pedro in California, from Ensenada in Baja California, from Ponce in Puerto Rico and from Paita and Chimbote in Peru. There are also local fisheries for tuna near Cape San Lucas in Baja California, near Manta in Ecuador and near Mancora in Peru, all using small vessels employing either bait or purse-seine methods.

It appears well documented that the stocks of yellowfin tuna in this area are distinct from those in the central and western Pacific. While the relationships of the skipjack populations of these areas are less well understood, they are probably distinct also, but may be subject to limited mixing in the intervening oceanic areas. At present, the nature of the population structure of each species within the boundaries of the eastern Pacific fishery are considerably less well understood. Since December 1955, the Commission has been conducting an intensive tagging program to approach this problem directly by the interpretation of the movements of recovered tagged individuals.

TAGGING METHODS AND RESULTS

The first successful tagging of Pacific tunas was done by scientists of the California State Fisheries Laboratory who developed a vinyl plastic loop tag (Wilson 1953) which was threaded beneath the second dorsal fin of the tuna and was secured in place by knotting the free ends of the plastic tubing. This tag was moderately successful but the rates of recovery from early experiments were low, probably due to tagging mortality, tag shedding and the failure of the fishermen and cannery workers to see and return the fish on capture.

From the inception of our tagging program we felt that the plastic loop tag was of sound basic design, but that considerable improvement could be made in the tag and its method of application. A possible weak point in the tag was at the knotted area and the first modification was the use of a stainless steel or monel metal clamp to securely fasten the two ends of the plastic loop, as shown

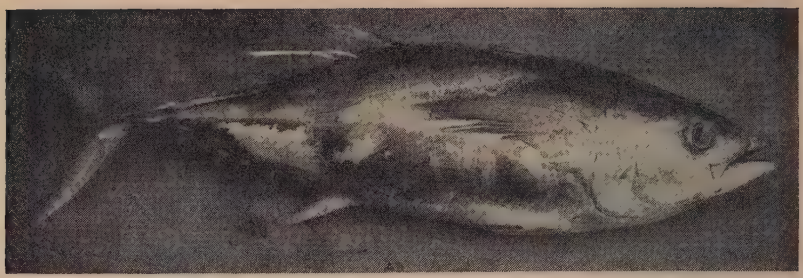

FIGURE 1. A yellowfin tuna tagged with a white plastic loop tag and recovered from the cutting line of a San Diego cannery.

in Figure 1. From December 1, 1955 to December 31, 1957, 6,227 yellowfin and 16,428 skipjack tunas were tagged with various modifications of this plastic loop tag. Of these, 73 yellowfin and 73 skipjack were tagged from purse-seine operations and the remainder from bait-boat operations.

Handling and Tagging Mortality

Because the tunas are powerful, yet delicate fish, their tagging has presented many difficulties not encountered with most fish. Their vigorous struggles during tagging may cause injury or excessive muscular fatigue and subsequent death after release. Black (1958) has shown that a prolonged exercise period resulted in a rapid increase in lactic acid levels in the blood and tissues of salmonoids. Death resulted, in many cases, either directly or indirectly from the experimental treatments. No direct measure of muscular fatigue has been possible with the tunas, but there appears to be good indirect evidence that fatigue may so debilitate the fish that they die or are easy prey to sharks and other predators after tagging.

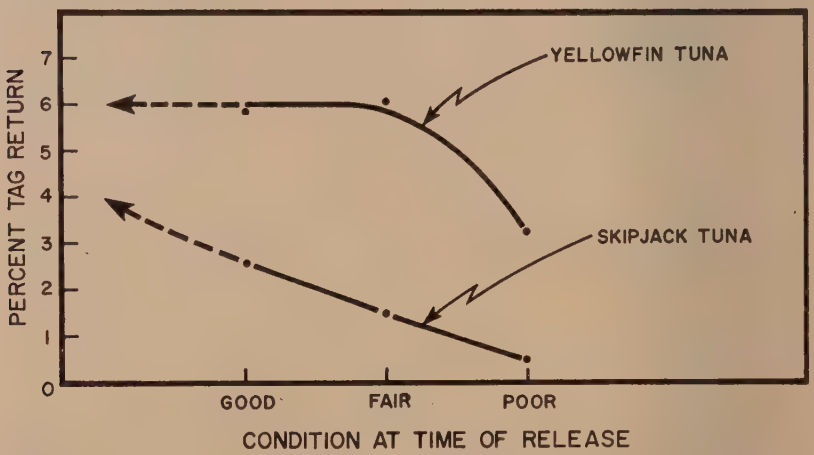

FIGURE 2. The percentage return of tagged yellowfin and skipjack tuna (to November 1, 1958) for the categories "good," "fair" and "poor."

To examine indirectly the possibility of tagging and handling mortality, yellowfin and skipjack tunas were graded as "good," "fair" or "poor," based on the time out of water, amount of struggling during handling, evidence of body injury and the swimming action of the fish on return to the water. The recovery rates of these three groups for all fish tagged to December 31, 1957, are plotted for each species in Figure 2. The curves are fitted by inspection and a dotted line extended in each case to indicate the possible rate of tag return on a further improvement in condition of the fish on release. For yellowfin tuna it appears that little improvement in tag return rate can be expected with further improvement in the condition of the fish at the time of release. However, for the skipjack, further improvement in handling techniques might result in a considerable increase in tag return rates. A chi-square test of the hypothesis that handling techniques do not affect the tag return rates was highly significant for skipjack and not significant for the yellowfin tuna.

Since tropical tunas cannot be held successfully in live-wells aboard the fishing vessel, they must be tagged and released directly after capture. From the inception of the program it was realized that the tagging and handling methods might result in a substantial initial mortality. A canvas tub filled with running sea water was used at first to immerse the tuna during tagging, but it was discarded when the splashing of the water hindered the tagging operation and did not seem to reduce fish injury. The use of anesthetics was also considered but it was found that the time necessary to quiet the fish before, and to effect recovery after tagging, was too great to make the method practical.

The following techniques were gradually evolved after many tagging cruises aboard live-bait vessels. The fisherman, positioned in the stern racks of the vessel, swings the tuna from the water to the tagger, who guides the suspended fish into a foam rubber lined "V" cradle placed on the stern rail of the vessel. The forward portion of the tuna, including the eyes, is covered with a wet burlap sack, the plastic loop tag is threaded through the fish about one-half inch below the second dorsal fin and the two free ends of plastic are fastened together with a metal clamp. The fish is immediately released over the stern and the tagging procedure is repeated as the next fish is captured.

A stopwatch was used to measure the time-out-of-water on a sample of fish during tagging by both experienced and inexperienced personnel on six cruises during 1957. A summary of these times is given in Table 1.

TABLE 1

THE RANGE AND MEAN TIME-OUT-OF-WATER, IN SECONDS, DURING THE TAGGING OF TUNAS WITH THE PLASTIC LOOP HELD IN PLACE WITH A HAND-APPLIED METAL CLAMP.

Cruise No.	*No. Observations*	*Time in Seconds*	
		Range	*Mean*
9	63	26-61	40.0
12	8	15-70	29.0
13	3	23-38	32.0
14	25	20-48	33.4
15	114	10-61	27.1
17	14	25-55	30.4

The mean time-out-of-water for the 227 observations was 31.7 seconds, with experienced taggers usually able to complete the operation in less than the mean time and inexperienced taggers taking longer.

Several models of an automatic tag applicator were designed and field-tested during 1956 and 1957 with the hope of reducing the tagging time. The first device threaded the plastic loop through the fish and applied a monel clamp in a single operation but numerous field difficulties prevented its successful use at sea. A simpler set of pliers, shown in Figure 3, was then designed to secure the two ends of the plastic loop together with a .040 monel wire staple, after the tag is threaded through the fish with a hand needle. After several modifications this device was tested during August and September, 1957, while fishing off the coast of Baja California (Cruise 14) and the recoveries compared with the hand clamp method of applying the loop tag. The releases and the subsequent recoveries of yellowfin and skipjack tuna tagged by each method are shown in Table 2.

TABLE 2

TAG RELEASES AND SUBSEQUENT RECOVERIES (TO NOVEMBER 1, 1958) OF YELLOWFIN AND SKIPJACK TUNA TAGGED WITH THE PLASTIC LOOP TAG SECURED WITH HAND CLAMP OR AUTOMATIC STAPLE.

Method	*Yellowfin*		*Skipjack*	
	Tagged	*Recovered*	*Tagged*	*Recovered*
Hand clamps	258	27	451	12
Automatic staples	315	31	455	55

The timing of a sample of 44 fish tagged with the automatic pliers gave a mean time out-of-water of 20.6 seconds. The returns of the skipjack tagged with the automatic pliers were much greater than those tagged with the hand clamps while the returns for each type of tagging of yellowfin tuna are quite similar. As the time-out-of-water is probably a fair index of fish condition on release after tagging it is not surprising that these data agree with the analysis of the condition experiment data. The automatic pliers offer two advantages in tagging skipjack,

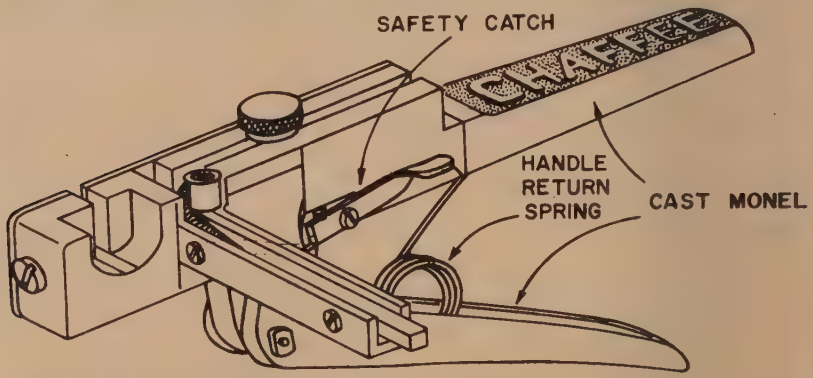

FIGURE 3. The automatic pliers for stapling the ends of the plastic loop tag.

a reduction in tagging time and presumable tagging mortality, and an increase in the number of fish that can be tagged in a given time of fishing; for yellowfin the latter appears to be the sole advantage of the automatic method of securing the loop tag.

Loop Tag Improvements

Examination of the tags returned from our first experiment indicated that the No. 18 XTE-30 vinyl plastic tubing was weakening after immersion in sea water, probably due to the leaching of the plasticizer, and that many of the tags could be easily broken. Beginning in August of 1956, 4,176 tagged tunas were released with every second tag strengthened by means of a No. 50 monofilament nylon core and by November 1, 1958, 75 of the strengthened tags and 48 of the non-strengthened ones had been returned from the fishery. A chi-square test of these returns indicated that the use of the nylon core resulted in significantly greater numbers of recovered tags. Losses of loop tags from breakage of the plastic can be estimated roughly at $\frac{(75\text{-}48)}{75} = 36$ per cent, if it is assumed that the addition of the nylon completely eliminated the breakage and shedding of the tags.

The search for a vinyl compound that would weather satisfactorily in sea water resulted in the development, by the Resinite Division of the Borden Company, Santa Barbara, California, of a material, resinite 271-1. This material, strengthened with nylon core for added tensile strength, is now being used in the manufacture of all our loop tags. Minnesota Mining and Manufacturing Co. has recently developed a tubing of braided spun glass dipped in liquid vinyl, which we are planning to test in the near future, because of its added strength and the ease of fabrication of the tags.

Plastic Dart Tag

Yamashita and Waldron (1958) have recently reported on a rapidly applied plastic dart tag used successfully to tag skipjack tunas in the Central Pacific area. We have tested a similar dart tag on 296 fish released during the summer of 1957 in the Gulf of Panama and on 986 fish released off Baja California during August, 1958. There have been no returns from the first experiment and five from the second, up to November 1, 1958. Four of the latter were returned from cannery operations and this suggests that the plastic dart tag (visible from one side of the fish only) is difficult to detect in the large catches of the American vessels, in contrast with the plastic loop tag (visible from either side of the fish), which has a better chance of detection during handling.

Detection of Recaptured Tagged Tunas

The fishing, handling and storage methods used aboard American tuna vessels are designed to handle large volumes of fish. It became evident during 1956 that a substantial number of the fish tagged with the white plastic loop tags were being overlooked by the fishermen, and that many of these tagged fish were being processed and the tags lost. To estimate these losses, a series of experiments were conducted in cooperation with scientists of the California State Fisheries Laboratory. Scientists aboard the commercial fishing vessels placed among the vessel catch, unknown to the crew, several tunas tagged with white plastic loop tags. On four separate vessels a total of twelve tagged yellowfin

tuna in all were planted in this manner. One fish was returned during the unloading of the vessel and another two were returned by cannery employees. The remaining nine tags were never found. At that time about three-quarters of our regular tag returns were coming from the vessels and the remaining one-quarter from the cannery operations. Excluding the one return from a portion of the vessel operation (unloading), the ratio of returns from the cannery to those lost suggests that about one half of the tagged tunas caught at that time were being lost during the normal course of handling and processing the fish. Some additional evidence of these losses was obtained by sifting the metal refuse from magnets in the meal line at a San Diego cannery. Two of the stainless steel clamps (slightly magnetic), used at that time to clamp the vinyl tag, were found in the refuse from several weeks canning operations. Because of the extreme inefficiency of the magnets in picking up these clips this examination of refuse was not continued.

To test the visibility of white, clear and yellow plastic loop tags, white and clear were used in alternate batches on three cruises during 1956, and white and yellow loop tags were used in 1957 during two trips from San Diego and several trips from Paita, Peru. The recoveries (to November, 1, 1958) from these experiments are given in Table 3.

TABLE 3

THE NUMBER OF RELEASES AND RECOVERIES (TO NOVEMBER 1, 1958) OF YELLOWFIN AND SKIPJACK FROM SEVERAL TAGGING EXPERIMENTS USING WHITE, CLEAR AND YELLOW PLASTIC LOOP TAGS.

	White		*Clear*		*Yellow*	
	Tagged	*Recov.*	*Tagged*	*Recov.*	*Tagged*	*Recov.*
Experiment #1.	1086	30	1062	23		
Experiment #2.	2405	50			2429	87

The testing of clear and white was abandoned when it became evident from the early recoveries that the clear vinyl tubing was not an improvement over the white. The yellow, however, showed immediate promise of improved tag return rates and a chi-square test of the returns shown in Table 3 indicated that there is a significant difference in the returns of yellow compared with the white plastic loops. Scientists at the California State Fisheries Laboratory tested red, blue and white (Personal communication) with no apparent improvement in tag return rates.

An Incentive Program for Obtaining Tag Returns

In addition to the recaptured tagged fish that pass undetected through the cannery operations, there was also the possibility that some of the detected recaptured tagged fish were not being reported due to a lack of interest or knowledge of our program. Since March 1957 we have been offering a reward of $1.00 per tag return and one chance at winning $300.00 at an annual drawing of one lucky tag number from those turned in during the calendar year. The tagging program was given wide publicity by means of English and Spanish posters placed in strategic waterfront locations in the tuna fishing ports of the United States, Mexico, Central America, South America and Puerto Rico. Results are

difficult to assess but we do feel that tag returns, especially from Latin American areas, have increased since the initiation of this reward program.

CONCLUSIONS

The returns of tagged fish from many of these experiments, especially those during 1957, are yet incomplete, and estimates of mortality rates, tag dispersion and the geographical distribution of sub-populations in the fishery are not yet possible. It can be said, however, that,

1. Improvements in the original plastic loop tag for tunas, in handling techniques and the establishment of a reward program have resulted in considerable increases in the rates of tag return for both yellowfin and skipjack tunas.
2. The results of the testing of the plastic dart tag are still inconclusive but it appears that the tag visibility is poor in the American fishery and may result in high losses of recovered but undetected tagged fish.

LITERATURE CITED

Black, Edgar C.
1958. Hyperactivity as a lethal factor in fish. J. Fish. Res. Bd. Canada, 15 (4), pp. 573-586.

Wilson, Robert C.
1953. Tuna marking, a progress report. Calif. Fish and Game, Vol. 39, No. 4, pp. 429-442.

Yamashita, Daniel T. and Kenneth D. Waldron
1958. An all-plastic dart type fish tag. Calif. Fish and Game, Vol. 44, No. 4, pp. 311-317.

Accumulation of Radioactive Materials by Fishery Organisms

Walter A. Chipman
Radiobiological Investigations
U. S. Fish and Wildlife Service

We are now living in a period in which there is tremendous expansion in the use of atomic energy. There is great interest in possible hazards to man of the radioactivity associated with the release of the energy of the atom. Of considerable concern is the contamination of man's environment with radioactive materials. Such materials added to the atmosphere, soil, and natural waters may be taken in by man and levels of radioactivity may be built up in the body sufficient to be damaging. In marine environments radioactive contaminants may accumulate in seafood organisms and affect their utilization or availability.

In discussing radioactive materials we need to consider that these materials are radioactive isotopes of chemical elements. In most cases the atoms that compose a chemical element differ in mass and those of like mass members, the isotopes, are present in definite ratios. For instance carbon, wherever it is found in nature, is composed almost 99 per cent of carbon atoms of mass

number 12 and about one per cent of carbon atoms of mass number 13. With the advent of man-made isotopes of carbon with other mass numbers, for example carbon-14, which is radioactive, it is possible to have carbon compounds in which the isotopic ratio is changed by inclusion of radioactive atoms. For the most part, the chemical and physiological processes of the body make use of elements to form compounds without discrimination as to their isotopic composition. Thus a radioisotope may be incorporated into the body tissues of marine plants and animals if present in their environment.

Living tissues accumulate chemical elements to different degrees. It is well known that certain elements, such as calcium and strontium, are concentrated in skeletal structures, such as bone and shell. Other elements are present in greater amounts in certain soft tissues and organs. Although maximum levels of concentration of an element exist, the elements composing the compounds of the body are constantly being replaced. Some compounds are broken down and reformed rapidly; others only slowly. If radioactive isotopes are included with the other isotopes of the element involved in the metabolism of marine organisms, an accumulation of radioactivity can result.

Radioisotopes may be added to a marine environment from the use of nuclear weapons and from the various operations required for the use of nuclear reactors. Some disposal may be made in coastal waters of a variety of radioisotopes used in industry, research, and medicine. They may be grouped into two general categories based on their origin. One includes the fission products resulting from the fission of uranium-235 and the other the radionuclides of elements produced from induced nuclear changes, generally from neutron bombardment resulting from the fission process.

Contamination of a marine environment from nuclear warfare can be from fission products and from induced radionuclides. Although there was an addition of fission products to the sea water from the testing of nuclear weapons in the Pacific Ocean, large contributions to the total radioactivity of certain fish were found to be from the non-fission product, zinc-65, and of certain molluscs from cobalt-60 (Weiss *et al.*, 1956). Many other induced radionuclides were also present in the fish and shellfish.

In the normal operations concerned with the use of nuclear reactors only insignificant amounts of radioactive materials are released to natural waters. Many reactors are cooled with water and the primary coolant water may contain radioactive materials. These may be radioisotopes of the elements normally present in water or present as corrosion products. They become radioactive from close association with the high neutron flux of the reactor core. Some fission products may be present if ruptures occur in the coverings of fuel elements. However, generally the primary coolant is contained within a closed system in which the heat is transferred through heat exchangers to a secondary coolant. Only through leaks within the heat exchangers would radioactive materials be passed to the secondary coolant. Small amounts of fission products are included in the waste effluents of chemical plants engaged in the reprocessing of irradiated and spent fuels. In a few instances low-level radioactive wastes from such plants are released into coastal waters.

It is the purpose of this paper to discuss the accumulation of radioactivity by marine fish and shellfish when fission product radionuclides and other radioisotopes are present in sea water.

For the most part the discussion is based on the experimental work of the

Radiobiological Investigations of the Bureau of Commercial Fisheries carried on at the Beaufort, North Carolina, laboratory. Some of the findings were described previously (Chipman, 1958) and details of many of the results are reported in the scientific literature or will be published shortly.

Accumulation of Fission Products

We may first consider the accumulation of radioisotopes of the fission products. We have measured the uptake of radioactivity by plankton, fish, and shellfish following the addition of mixed fission products of nearly one year of age to sea water or administered in foods. We have made radiological analyses of the accumulated radioactivity to determine the radioisotopes responsible for the activity. In order to further understand accumulation patterns, we have tested the uptake and accumulation of several of the individual radionuclides of such mixtures.

Table 1 shows some of the radionuclides produced in the fission of uranium that may be considered as biologically important and the per cent they contribute to the total radioactivity after different periods of time. The great majority of those having a significant contribution from twenty days up to about one year of age are those of the rare earth elements or those having chemical characteristics similar to rare earths. The importance of strontium-90 and cesium-137 in aged fission products is apparent.

TABLE 1

Per cent of Total Radioactivity Contributed by Certain Fission Products of Biological Interest at Different Times After Fission.[1]

	20 days	90 days	1 year	3 years	10 years	20 years
Sr^{89}	5.0	10.5	2.7	—	—	—
Sr^{90}-Y^{90}	—	—	3.7	17.4	44.0	48.0
Y^{91}	5.6	12.5	3.8	—	—	—
Zr^{95}	5.9	14.7	7.2	—	—	—
Nb^{95}	2.3	18.0	14.7	—	—	—
Mo^{99}	1.3	—	—	—	—	—
Ru^{103m}	4.4	7.2	0.8	—	—	—
Rh^{103}	4.2	7.0	0.8	—	—	—
Ru^{106}-Rh^{106}	—	—	4.9	6.0	—	—
I^{131}	5.6	—	—	—	—	—
I^{132}	1.1	—	—	—	—	—
Cs^{137}-Ba^{137m}	—	—	2.9	13.6	36.0	45.0
La^{140}	13.9	1.8	—	—	—	—
Ba^{140}	12.0	1.6	—	—	—	—
Ce^{141}	9.7	8.5	—	—	—	—
Pr^{143}	12.0	11.2	2.6	—	—	—
Ce^{144}-Pr^{144}	2.6	12.0	52.8	42.0	—	—
Nd^{147}	5.0	—	—	—	—	—
Pm^{147}	—	—	5.7	19.0	16.0	3.4
Sm^{151}	—	—	—	1.1	2.5	2.6

[1]Adapted from data of Hunter and Ballou (1951). Reference, Chipman (1958).

The availability of radionuclides for uptake by marine fish and shellfish is dependent in part on their chemical nature and physical state when present in the sea water. When fission products of about one year of age are added to sea water, the greater part of the radioactivity will be present in the form of

particles. As seen in Table 2, only radioisotopes of strontium and cesium remain as the important fission products of mixtures of this age in solution. The nature of the ruthenium compounds is difficult to predict, but in our tests we had precipitation of ruthenium when employing ruthenium-106 at the pH of sea water.

Not only may there be a formation of particles, but there is also a marked adsorption of many radionuclides to the surfaces of particles. There is a great abundance of particles in natural sea water, especially in certain inshore waters. This adsorption of radionuclides to both living and non-living particles in sea water is of considerable significance in discussing the fate of radioactivity added to marine environments.

Accumulation by plankton

In the sea the primary concentrators, the photosynthetic plants, take chemical elements directly from the water. For the most part, these plants are the minute single-celled algae, the phytoplankton. Because of their small size they offer tremendously large surfaces for adsorption. An accumulation of radioactive materials by these forms may be passed to marine animals through the food webs of the sea.

In the Pacific Ocean following the testing of nuclear weapons, high radioactivity was found in the plankton, the nannoplankton samples having higher radioactivity than those composed of larger organisms (Harley, 1956).

TABLE 2

PROBABLE STATE OF CERTAIN FISSION PRODUCTS WHEN PRESENT IN SEA WATER

Particulate	Solution
yttrium-91	strontium-89
zirconium-95	strontium-90
niobium-95	ruthenium-103*
praseodymium-143	ruthenium-106*
cerium-144	cesium-137
promethium-147	

*Questionable

In laboratory culture planktonic algae rapidly take up radioactivity when fission products are added to the sea water medium. In a very short time nearly all the radioactivity of added mixed fission products is associated with the cells. In tests with separated fission products we found very great accumulation of some radionuclides. These would thus be available in concentrated amounts for passage through the food webs to marine animals. There was great accumulation of ruthenium-106. The rare earth radionuclide, cerium-144, was accumulated many thousands of times above sea water concentrations as shown from the concentration factors listed in Table 3. Radioisotopes of yttrium are markedly concentrated. The experiments indicate that much of the accumulation of many radionuclides is related to surface areas.

Marine algae may be of little importance in passing certain radionuclides to animals. These include the radioisotopes of strontium and of cesium. As seen in the concentration factors listed in Table 4, marine species of phytoplankton do not concentrate cesium-137 appreciably. Although some species concentrate strontium, many take up only small amounts of radiostrontium added to the sea water in which they are grown (Rice, 1956).

With few exceptions the fishes and many other animals are not equipped to feed directly on phytoplankton. They depend on other forms which possess mechanisms which allow this type of feeding. An important group of phyto-

TABLE 3

CONCENTRATION FACTORS OF Ce^{144} FOR VARIOUS SPECIES OF PLANKTONIC ALGAE, CALCULATED ON A WET WEIGHT BASIS

Algae	Number of times over sea water concentration	
	After 0.5 hours	After 24 hours
Carteria	314	2422
Platymonas	1843	2127
Nitzschia	518	1970
Thallassiosira	2610	3346
Amphidinium klebsi	3001	4498
Porphyridium	802	3344

TABLE 4

CONCENTRATION OF CESIUM BY MARINE ALGAE.[1]

Algae	Concentration factor[2]
Bacillariaceae	
Nitzschia closterium	1.2
Amphora sp.	1.5
Nitzschia sp.	1.7
Chlorophyceae	
Chlamydomonas sp.	1.3
Carteria sp.	1.3
Chlorella sp.	2.4
Pyramimonas sp.	2.6
Nannochloris atomus	3.1
Rhodophyceae	
Porphyridium cruentum	1.3

[1]Boroughs, Chipman, and Rice (1957).
[2]The concentration factor is reported as the ratio of Cs^{137} in the algae (wet weight) to that in an equivalent weight of sea water at an apparent steady-state condition.

plankton feeders is the small animal plankton. These are eaten by small fishes which may serve as food for others still larger.

We have observed that marine copepods and other filter-feeding zooplankton forms do rapidly become radioactive when exposed to sea water in which are suspended radioactive phytoplankton cells and other radioactive particles.

The copepod, *Tigropus californicus,* removed nearly all the radioactive cerium available in the sea water and food giving the animal a high concentration over the water. Likewise, brine shrimp feeding on *Nannochloris* cells containing ruthenium-106 became radioactive from their water filtration. Apparent high concentration factors can result when such accumulation of radioactive food particles can be collected from large volumes of water.

As regards the fission product radionuclides present as particles or associated with the phytoplankton food, the great majority are those poorly absorbed from the digestive tract. Consequently, the accumulation of radioactivity by the filtering zooplankton is related to the presence of radioactive particles on

the filtering mechanisms and concentrated within the digestive tract. They fail to accumulate significant amounts of fission product radionuclides in their bodies. When the radioactive particles are no longer available, the accumulated radioactivity of the zooplankton forms is rapidly lost, depending on the time for the clearing of the digestive tract. An example of the rapid loss of accumulated cerium-144 by copepods is shown in Table 5. The accumulation was due almost entirely to a concentration of particles.

TABLE 5

RETENTION OF CERIUM-144 BY THE COPEPOD, *Tigropus californicus* (AVERAGE OF 22 INDIVIDUALS)

Days	Activity c.p.m./copepod	Per cent remaining
0	7103	100
1	227	3.2
2	123	1.7

Zooplankton may accumulate radionuclides present in the water in solution. If accumulated to any marked extent, appreciable concentrations may be passed to fishes using these forms as food. Two important fission product radionuclides that may be considered in this connection are strontium-90 and cesium-137. Both are readily taken up from the water and both pass quickly into the body from the digestive tract.

A few species of zooplankton have calcareous structures and may concentrate strontium. Many species do not. We have measured concentration factors for radiostrontium of about one for the copepod, *Tigropus*, and less than one for the brine shrimp, *Artemia* (Figure 1). When phytoplankton food is present, however, a concentration of particles filtered from the water with concentrations of strontium may give an apparent concentration factor somewhat greater than one, particularly if the factor is calculated per unit volume of water disregarding the abundance of phytoplankton cells. Cesium-137 is slowly concentrated through a slow accumulation (Figure 1).

From the foregoing we can see that the zooplankton become radioactive from an accumulation of radionuclides from fission product mixtures, but that they can pass the accumulated radionuclides farther up the food web only while these are within the digestive tract, for the greater part of the radioactivity is due to those that are poorly absorbed from the digestive tract. A concentration of radiocesium in their bodies may permit the transfer of the accumulated radionuclides of cesium to small fish using zooplankton forms as food.

Accumulation by shellfish

Oysters, clams, and scallops are important fisheries organisms which filter large volumes of water and feed on the filtered material. As may be expected, the story of the accumulation of radionuclides of fission product mixtures present in sea water in the form of particles is exactly the same as that of the accumulation by the small animal plankton forms. They concentrate radioactive particles markedly. Often the greater part of the measured accumulation is due to association of particles with body surfaces and their presence in the organs and structures connected with the digestive tract. A great number of

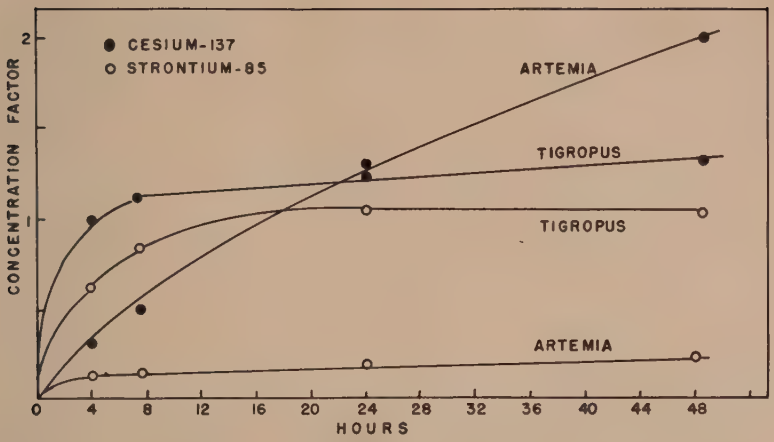

FIGURE 1. Accumulation of cesium-137 and strontium-85 by the copepod, *Tigropus californicus,* and the brine shrimp, *Artemia salina,* maintained in filtered sea water containing the isotope.

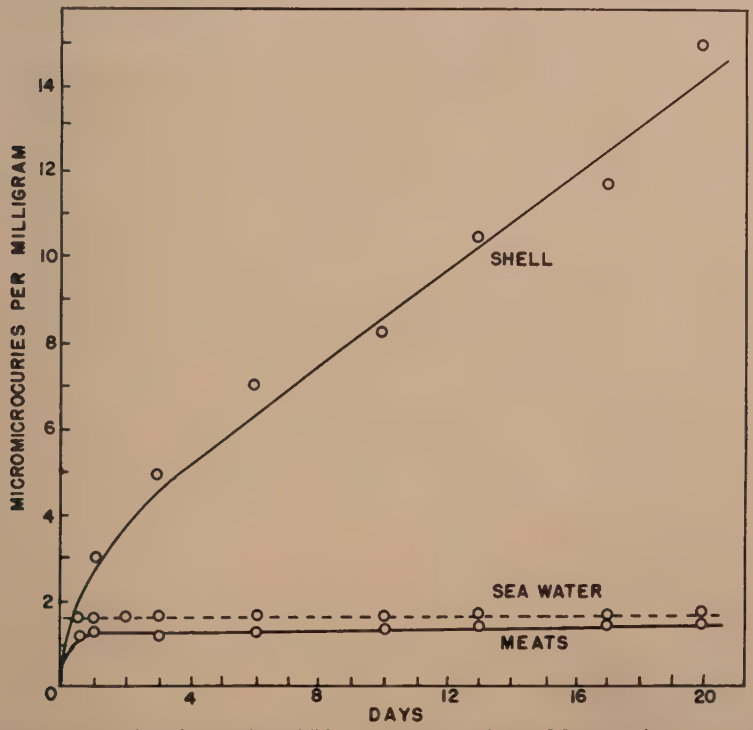

FIGURE 2. Uptake of strontium-85 by young hard clams, *Mercenaria mercenaria.*

fission product radionuclides are not absorbed readily from the tract and are not accumulated or concentrated in body tissues and structures. However, such an accumulation of radioactive particles may be important for purposes of passage through food webs and to man. The fact that man eats the whole soft tissues of oysters and clams allows for the ingestion of many radionuclides that may not be metabolized and incorporated into the tissues of these shellfish.

Strontium radioisotopes are taken up by oysters, clams, and scallops. Uptake is primarily from the water, for there is no great accumulation in their food. The strontium is concentrated in their shells. There is no concentration of strontium in the soft tissues. Figure 2 shows the accumulation of radiostrontium in the shells and meats of hard clams. A concentration factor of less than one over that of the water was found for the meats. Aside from accumulation from the formation of new shell, there is an uptake of considerable magnitude by shells separated from the meats. This accumulation of radioactivity by shells may be of interest in view of the fact that shells are placed on the bottom by oystermen as cultch for the attachment of the young oyster spat.

Cesium-137 is accumulated to relatively high levels by the soft tissues of shellfish. There is a more rapid uptake by the soft tissues other than muscle, but the highest concentrations are reached in time by the muscles. An example of this differential uptake is shown in Figure 3, which shows the accumulation of cesium-137 by scallops. In ten days the concentration in the adductor muscle of scallops was ten times that of the water and increasing. Actually, the uptake continues for very long periods of time.

We have found that clams concentrate cesium-137 to a greater extent than do oysters, which is in agreement with the difference in their body structure

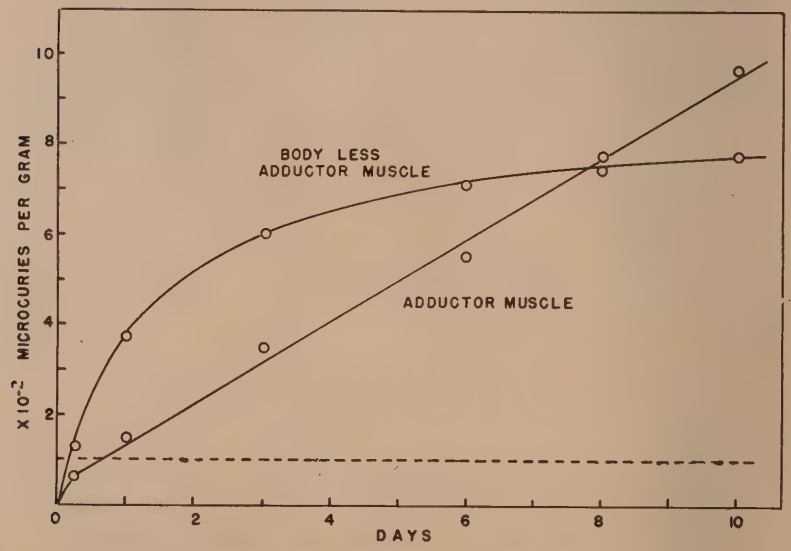

FIGURE 3. Uptake of cesium-137 by the body tissues of the bay scallop, *Pecten irradians.*

as regards muscle tissue. As far as the hazards to humans is concerned from the ingestion of cesium from shellfish, the most hazardous is the scallop, since only the adductor muscle is eaten. Clams would be more hazardous than oysters.

Only small amounts of the radioactivity of mixed fission products administered entered the body tissues of edible crabs and shrimps. Of that that did enter, the greater part was present in the internal organs. Daily oral doses to the blue crab resulted in a gradual accumulation of radioactivity in the shell and in the edible muscle.

In crustacean shellfish, there is an accumulation of strontium radioisotopes in the shell and other calcified structures. Molting results in the loss of the concentrated radioactivity. We have found no concentration of radiostrontium in the muscles.

The radioisotope of mixed fission products that seems to be of most importance in regard to its accumulation by shellfish is cesium-137. It is concentrated to relatively high levels in the edible meats. In the practice of "heading" of shrimp for market, the accumulated radioactivity of the internal organs and a major part of the shell is discarded. However, relatively high concentrations of radioactive cesium would be present in the marketed portion.

Accumulation by fish

Marine fish, like the invertebrates, take up only small amounts of most of the radionuclides of fission products when taken into the digestive tract. Since the greater part of the radioactivity of a mixture of about a year of age is due to radionuclides of the rare earths and others poorly absorbed through the intestinal wall, very little of the accumulated radioactivity of fish is due to these radionuclides. Table 6 shows the loss of fission product radioactivity from bluefish and croakers at various times after oral administration and the small amounts taken up by the tissues. Croakers given the rare earth radionuclide,

TABLE 6

PER CENT OF ORAL DOSE OF FISSION PRODUCT MIXTURE PRESENT IN FISH AFTER DIFFERENT PERIODS OF TIME

(TEST WITH MFP-1 OF AGE 143-151; 196-199 WITH CROAKERS, AND MFP-1 OF AGE 216 DAYS WITH BLUEFISH)

	Hours after dose	Per cent of oral dose remaining: Digestive tract	Body	Total fish
Bluefish (individually)	½	100	0	100
	1	90	6	96
	2	76	2	78
	4	(16	(2	(18
		(14	(5	(19
	8	3	1	4
Croakers (average of 3)	3	43	14	57
	6	56	7	63
	28	5	4	9
	69	2	0.8	2.8
	137	0.4	1.6	2.0

cerium-144, by pipette into the stomach had only about three or four per cent of the radioactivity of the dose in their tissues. Menhaden fed phytoplankton cells containing ruthenium-106 took up only about one per cent of the radionuclide (Table 7).

TABLE 7

RADIOACTIVITY OF MENHADEN AFTER FEEDING ON PHYTOPLANKTON CELLS CONTAINING Ru^{106}

(TISSUES OF 5 FISH ANALYZED FOR EACH OBSERVATION)

Time in hours	Per cent of dose			
	Gills	Digestive tract and contents	Remainder of fish	Total in fish
0	0.64	92.39	0.76	93.79
2	0.05	80.09	1.00	81.14
4	1.13	21.15	0.53	22.81
8	0.06	7.99	0.34	8.39
16	0.08	8.50	0.56	9.14
32	0.02	5.23	0.22	5.47
64	0.02	1.48	0.26	1.76
128	0.01	0.05	0.25	0.31

Although only a small amount of the total radioactivity enters the body of the fish, certain radionuclides are taken up rapidly, and these are markedly concentrated in the fish tissues, particularly in the skeletal structures. Table 8 shows the body distribution of the radioactivity of mixed fission products in bluefish four hours after administration. There was considerable radioactivity in the internal organs and in bone and scales. Repeated daily doses of mixed fission products to fish resulted in marked concentration of strontium-90 in the bones and scales, and a gradual accumulation of radioactivity in the body muscles. The latter was due to the uptake of cesium-137. The greater part of the radioactivity of the internal organs was due to rare earth radionuclides.

TABLE 8

DISTRIBUTION OF RADIOACTIVITY IN THE BODY OF BLUEFISH 4 HOURS AFTER ORAL DOSE

(FIVE PER CENT OF DOSE IN BODY. β ACTIVITY MEASURED DAY AFTER ADMINISTRATION)

Part or organ	Gross β radioactivity	
	Per cent of total fish	d.p.s./gm.
Body less digestive tract and internal organs	96.4	331
Muscle		41
Bone		463
Integument		539
Liver	2.0	858
Internal organs other than digestive tract and liver	1.6	438

d.p.s.—disintegrations per second

However, we have found from repeated doses of the rare earth, cerium-144, to croakers that, although the radionuclide is rapidly concentrated in the liver, the greatest accumulation is ultimately in bone.

There is no concentration of strontium radioisotopes in the edible body muscles of marine fishes. Continuous exposure of small mullets to strontium-85 for thirty days (Figure 4) resulted in a concentration factor over water of only 4.6. In these the greater part of the weight of the fish was due to body muscles, while the greater part of the radioactivity was from accumulation in bone and scales. The body muscles of the killifish (*Fundulus heteroclitus*) had a concentration factor for strontium-85 of only 0.15 after exposure of the fish to the isotope in sea water for thirty-two days (Figure 5).

Cesium-137 is accumulated in the edible fish flesh and significantly high concentrations can result. The rate of accumulation in internal organs is more rapid than by muscle tissues, but the long-continued uptake by muscles of this radionuclide of long physical half-life can be of great importance when continuously available for uptake. The accumulation of cesium-137 in the body

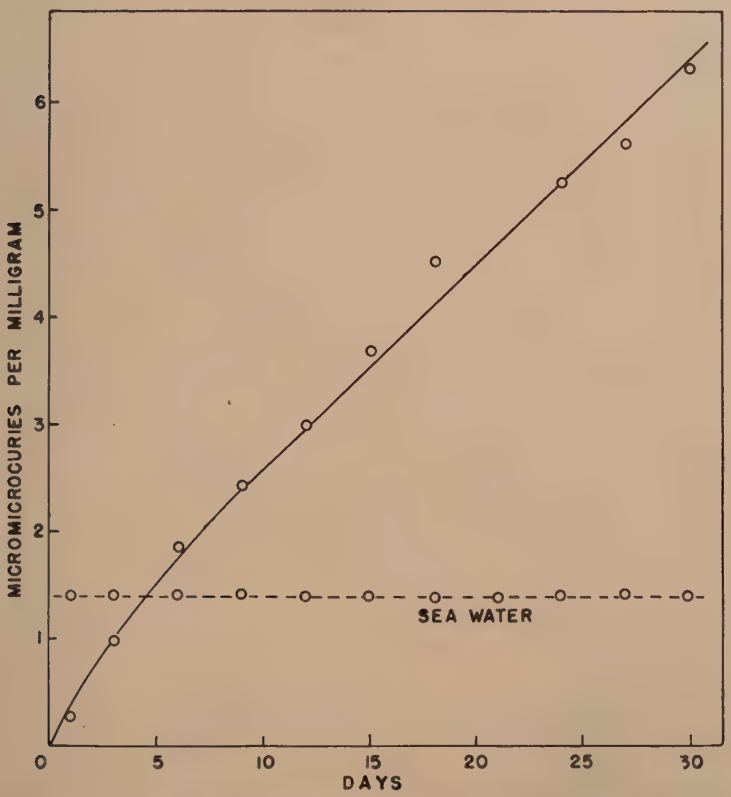

FIGURE 4. Uptake of strontium-85 by young mullets, *Mugil cephalus*.

muscles of *Fundulus* is shown in Figure 6. Accumulation was still continuing after an exposure of seventy-two days when the concentration was about thirty-five times that of the water. Fish continuously bathed in sea water containing cesium-137 and eating foods that contain concentrations of the nuclide would gradually accumulate relatively high concentrations in the edible flesh.

Accumulation of Other Radionuclides

Besides the radionuclides of fission product mixtures, we need consider accumulation of certain of the trace elements of sea water. Included in this category are isotopes of iron, manganese, copper, cobalt, and zinc. To date two of these, radiozinc and radiocobalt, have been studied in our laboratory. A report (Chipman *et al.*, 1958) has been made of the accumulation of radioactive zinc.

When zinc-65 or cobalt-57 are added to sea water in which marine phyto-

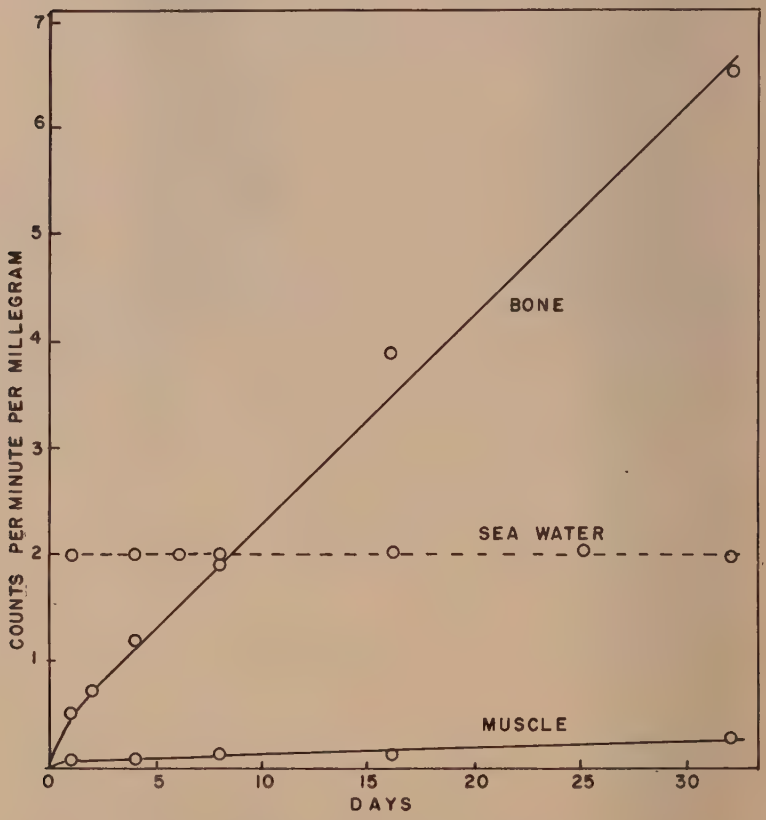

Figure 5. Accumulation of strontium-85 in muscle and bone of the killifish, *Fundulus heteroclitus*.

plankton cells are suspended, there is rapid and extensive uptake of the radionuclides. A species of *Nitzschia* was found to concentrate zinc many thousands of times over sea water concentrations. Likewise, phytoplankton cells accumulated cobalt-57 very markedly. It is obvious that, if radioactive zinc or cobalt were added to the sea, high concentrations would be found in phytoplankton and could be passed to animals using these cells as food.

Although these metals are present in sea water in low concentrations, they are markedly accumulated by marine animals. Tests made of the accumulation of radiozinc and radiocobalt by copepods demonstrated that both are taken up rapidly and to high concentrations, the radiozinc being accumulated to levels over 200 times that of the water in 48 hours with the accumulation continuing. In the same length of time radiocobalt concentration was about fifty times that of the water. Oysters, clams, and scallops concentrate large amounts of zinc, thousands of times more than the sea water. They also concentrate cobalt very markedly. Marine fish were found to take zinc-65 into the body tissues very rapidly with accumulation in the bone, integument, and muscle tissues. High concentrations of zinc-65 were present in the internal organs, notably in the kidneys.

It is apparent that the radioisotopes of the trace metals, zinc and cobalt, added to sea water are quickly taken up and concentrated to high levels by the biota. They are readily transferred through the food web, being passed through the lining of the digestive tract very promptly and accumulated to high levels in the body tissues. Pollution of estuaries or coastal waters with significant amounts of these could create hazardous situations affecting the utilization of our seafood resources.

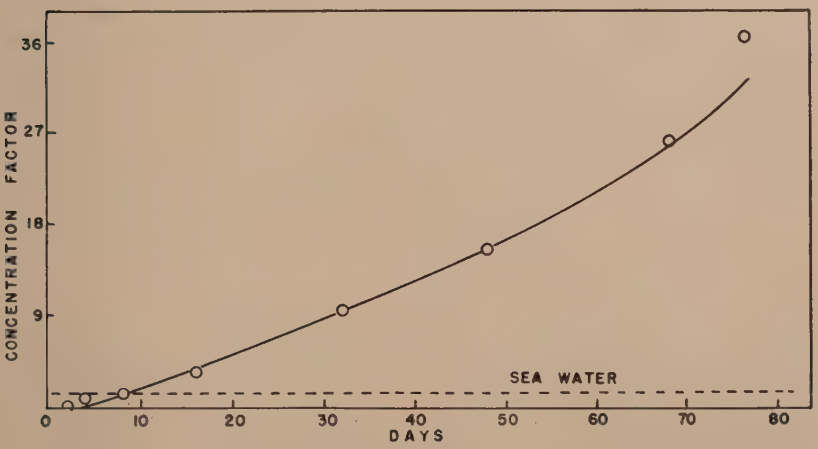

FIGURE 6. Accumulation of cesium-137 in the body muscles of the killifish, *Fundulus heteroclitus*.

LITERATURE CITED

Boroughs, Howard, Walter A. Chipman, and Theodore R. Rice
1957. Laboratory experiments on the uptake, accumulation and loss of radionuclides by marine organisms. *In* The Effects of Atomic Radiation on Oceanography and Fisheries, Publication No. 551, National Academy of Sciences—National Research Council, Washington, pp. 80-87.

Chipman, Walter A.
1958. Biological accumulation of radioactive materials. Proceedings of the First Texas Conference on Uses of Atomic Energy, pp. 36-41. Special Publication of the Agricultural and Mechanical College of Texas, College Station, Texas.

Chipman, Walter A., Theodore R. Rice, and Thomas J. Price
1958. Uptake and accumulation of radioactive zinc by marine plankton, fish, and shellfish. Fishery Bull. 135, Fishery Bull. Fish and Wildlife Service, *58:* 279-292.

Harley, John E. (Editor).
1956. Operation Troll. N. Y. Operations Office, U. S. Atomic Energy Commission, Document NYO4656, 37 pp.

Rice, T. R.
1956. The accumulation and exchange of strontium by marine planktonic algae. Limnology and Oceanography *1:*123-138.

Weiss, H. V., S. H. Cohn, W. H. Shipman, and J. K. Gong.
1956. Residual contamination of plants, animals, soil, and water of the Marshall Islands two years following Operation Castle fallout. Research and Development Report, U.S.N.R.D.L.—455, U. S. Naval Radiological Defense Laboratory, San Francisco 24, California, 55 pp.

DISCUSSION

Biological Session

Discussion Leader: K. M. Rae
Discussion Panel: Eugenie Clark, Walter Gresh
R. Winston Menzel, Paul S. Galtsoff

Parasites and Fishery Problems

William J. Hargis, Jr.

Q. Gresh: How do you answer the public when they ask you whether they should eat wormy fish?

A. Hargis: I would say that if they cook the fish they are not harmful. I advise never to eat uncooked fish.

Q. Galtsoff: I wonder why you completely disregarded the distinction between pathogens and commensals.

A. Hargis: The problem of classifying the symbiotic relationship is difficult, and I wanted to restrict the discussion specifically

to problems in which the whole group might be interested.

Q. Clark: Have you ever come across a "jellied" condition in fishes in your region? We recently had batches of jellied flounder brought in to our laboratory from the northern part of the Gulf of Mexico.

A. Bullis: Flounder seem to suffer severely from this condition. On several occasions, trawling at the seventy-five to one hundred fathom depth range, between the Mississippi Delta and Pensacola we have caught affected *Paralichthys squamilentis*. They will not stand freezing or icing. Unless they are cooked as soon as they are caught, they deteriorate on cooking.

Q. Clark: When skin diving away from cooking facilities, I often eat raw fish freshly speared. Do you think that there is any truth to the idea that offshore surface fish, such as mackerel and tuna, are comparatively free from parasites that are harmful to man?

A. Hargis: I think in general that that would be an assumption that one could make.

Galtsoff: (Comment) You can get very serious sickness from eating raw clams, and parasites have been found to be the cause of that sickness in the New England area. I would not recommend eating them raw.

Hargis: (Comment) I would like to ask for collections of monogenetic trematodes. If you encounter fish with these parasites, cut the gills out of the fish, or put the fish, while they are still alive, in jars conaining a saturated solution of chloretone, or chloropropanol, label, and then two hours later add a little bit of formaldehyde to bring it up to about four to six per cent. It is important to have the host identified accurately. The worms should be relaxed before they are preserved. Some occur on the skin of larger fishes, dolphins, ocean sunfishes, etc., and these should be scraped off and pickled in the same way. If no other solutions are available Epsom salts followed by potable spirits are in order.

A New Fishery for Scallops in West Florida

HARVEY R. BULLIS, JR. AND ROBERT M. INGLE

Q. Menzel: You identified this scallop as *Aequipecten gibbus*. Why have you separated it from the bay scallop?

A. Bullis: The taxonomy of *Aequipecten gibbus* is confused. The only satisfactory distinction that I have been able to find between *P. gibbus* and *P. irradians* is that the latter occurs in the grass flats, generally in the bays, and the *gibbus* in the open Gulf or Atlantic Ocean. Until the species complex is studied carefully throughout its range we will apply the names tentatively.

Q. Galtsoff: Do I gather that you can separate the two species only from an ecological point of view?

A. Bullis: It is difficult to separate them by shell characteristics, and a satisfactory separation is only possible, apparently, on the basis of ecology.

Improved Techniques for Collecting Seed Oysters in the Chesapeake Bay Area

David H. Wallace

Q. Clark: Did you get a higher percentage of survival, or larger oysters at the top of the baskets than lower down?

A. Wallace: The ones on the outside of the baskets grew faster than those on the inner surface or in the middle of the basket. There seemed to be little difference in growth from the top to the bottom.

Q. Clark: You mentioned that from oysters that were scattered over the bottom the recovery was only about sixty per cent. Is that due to the death of the oysters or to the fact that they cannot find them again?

A. Wallace: It is due to three things. First, it is difficult to find them, second, there is more settling of the material to the bottom and finally, there are rather extensive mortalities when the shells are on the bottom with heavy sets attached.

Q. Galtsoff: Are these baskets essentially like a tripod, and do they sit vertically?

A. Wallace: Yes, they act like a tripod. When they are dropped overboard, they go directly down without falling over. If they are thrown they fall and land on their sides, but if they are dropped carefully they stand up.

Q. Galtsoff: How many of these bags can you put on an acre?

A. Wallace: Probably fifteen thousand.

Menzel: (Comment) I certainly agree with you that the industry should make more use of what the oyster biologists have found out.

Wallace: (Comment) As a criticism of both biologists and oyster men, all too frequently the biologist, after carrying on studies and arriving at definite conclusions, then expects the industry immediately to take the results and put them to some practical application. I do not believe that it is quite as simple as that. The only reason that this bagging operation in the Chesapeake Bay is a practical one is because of the engineering advance to make it possible to make a bag at a very cheap cost. Up until three years ago these bags had to be made by hand and they cost forty-five cents apiece, which was too expensive. Now they are making them for sixteen cents with a machine. I feel strongly that we need another step between the biologist and the commercial industry, a developmental organization, which would take the findings of the biologist and translate them on a pilot plant basis into semi-commercial operation and eventually a commercial operation.

Q. Gresh: Why are more of the states not using the baskets rather than dumping the shell out indiscriminately?

A. Wallace: Most state operations are not properly managed. That is a great tragedy. Many states are spending large sums of money in their oyster culture practices and ending up with very little. I am speaking in generalities and I am sure that there are places where that is not true. However, I would not recommend bagging of shells in every case. For example, in South Carolina I am sure it would be useless because the conditions there are so different.

Q. McConnell: In Alabama, would you recommend bags instead of planting the shells on the bottom?

A. Wallace: I do not think that you would gain much by putting the bags on the bottom and leaving them there. What you might very well do is to put the bags over, get the spat sets and within two or three weeks, before you have had excessive predation, move the bags into areas where you have good growing conditions and break the bags up to scatter the shells.

Ingle: (Comment) In Florida we are trying to establish fishable oyster grounds for the industry which will be there in perpetuity. We spray the shells off the barges, but we pile them up six to nine feet deep. We are not interested in cultivating oysters for the people to go out and harvest in a year and make a quick killing. We are interested in making and maintaining natural reefs. From our point of view, what we are trying to do seems desirable and we are doing that rather than put shells in the bags as you recommend for private industry.

A. Wallace: I am not advocating that everyone drop what they have been doing and start putting shells into bags. In certain circumstances we have basic factual information which indicates that this is a good technique. Where the conditions are proper for this type of operation, it can be made into a successful commercial way of growing first quality seed.

Progress in Atlantic Coast Shad Investigations

GERALD B. TALBOT

Q. Gresh: How important is the sport catch of shad compared with the commercial catch?

A. Talbot: Although sport catches are increasing tremendously in shad rivers, as yet they are very slow in comparison with commercial catches. Roughly not more than five per cent of the return came from sport fishermen. The sport fishermen take the biggest toll of shad from a few rivers like the St. John's River in Florida. In the St. John's River last season it was estimated that some sixty thousand fish were taken by sport fishermen. It is rapidly becoming more valuable as a sports fish there than as a commercial fish.

Q. Galtsoff: Your results are significant not only for practical purposes, but from the point of view of a theoretical biologist, because they give such good support of the home stream theory. But there still remains to be gathered another piece of evidence to be completely sure that the theory is accurate. That is to tag the young shad as they leave a certain stream and have them recovered there again as adults. Do you plan to carry out this aspect of the work to get definite proof of the parent stream theory?

A. Talbot: One difficulty is that the female spawns an average of 250,000 eggs. The survival is rather high in the rivers, and if the run merely maintains itself, only two fish come back from 250,000 potential. Therefore, astronomical numbers of tags would have to be put on to get any kind of return of fish tagged as young. Then again, these very small plastic tags in the body cavity of the fish are not readily seen when the fish is cleaned, so that many of those returned would not be seen. However, the indirect evidence is becoming so strong that we have very little doubt about the validity of the home stream theory in shad. For the last six years we have been able to predict in advance within 10 to 15 per cent what size of run would be returning to the Hudson River and the Connecticut River.

The Tagging of Yellowfin and Skipjack Tunas in the Tropical Pacific Ocean

GORDON C. BROADHEAD

Q. Clark: Do you suspect that large numbers of tags are missed in studies on other types of fish?

A. Broadhead: There are actually two points. This first is that tags are missed because nobody sees them, and the second that tags are missed because of lack of interest.

Q. Galtsoff: Is there some other method of marking tuna fish, by branding or by some kind of harpoon, so that you do not have to bring the fish up on deck?

A. Broadhead: Almost everything has been tried. We did try the harpoon-type tag on skipjack, which takes about half the time to apply. It is satisfactory, except that this tag is only about a quarter visible. Also, tunas are rapid swimmers and we need a very specialized type of tag that creates very little water resistance.

Q. Menzel: Are any of those fish caught immediately after being tagged?

A. Broadhead: In the case of skipjack they are caught quite soon after. We have one recovery from the same school at the same time that we were tagging the skipjack. From yellowfin tuna we usually get very few recoveries for the first month. Our longest return is about two years.

Q. Bullis: How far do the yellowfin tuna migrate?

A. Broadhead: These fish do not migrate great distances. The longest migration was around nine hundred miles, and one or two hundred miles is quite uncommon.

Accumulation of Radioactive Materials by Marine Organisms

WALTER A. CHIPMAN

Q. Galtsoff: Would it be possible to use selected cultures of plankton which concentrate radioactive materials very rapidly for the removal of radioactive substances from the water?

A. Chipman: The results of tests to date have shown that there is only a limited uptake of certain radioactive materials, so not all are removed. The most dangerous ones are not concentrated by the plankton in sufficient quantities to allow plankton to be used in this way.

Q. Galtsoff: Is the problem of pollution by radioactive waste really a very serious one when more and more nuclear reactors will be of the fusion rather than the fission type?

A. Chipman: Fusion reactors will come, but they will not come soon enough. We will have a tremendous expansion in the use of fission reactors so that we will be confronted with disposal problems of fission waste for years to come.

Q. Menzel: What is the possibility of contamination from atomic ships?

A. Chipman: There is a terrific expansion planned in atomic merchant ships, quite apart from warships. These ships will have at least one reactor and each of these will require a cooling system. In passing through the reactor the coolant material will become radioactive. The induced radioactive nuclides are removed from the coolant on ion exchange resins. The coolant and resins appear to be the chief concern in possible contamination from atomic ships. At present the resins from the United States merchant ships are to be taken ashore and disposed of, probably by burial. We do not know what the plans will be for the disposal of materials from ships from other countries. They might not be as careful. There is also the problem of possible contamination of estuary areas from shipwreck.

FRIDAY—NOVEMBER 21

Chairman—RICHARD T. WHITELEATHER, *Assistant Regional Director, U. S. Fish and Wildlife Service, St. Petersburg Beach, Florida*

The Recreational Potential of Marine Fisheries

DANIEL H. JANZEN
Director, Bureau of Sport Fisheries and Wildlife
Washington, D.C.

UNTIL TWO YEARS AGO I was a midwesterner, and water—to me—was for drinking, for raising ducks, and for trying to get carp out of or put trout in. Of course, I knew there was salt water for sailors and sailfish, and for swimming, but it didn't mean much to me. The region for which I was responsible before coming to Washington was the only one in the Service that nowhere touched salt water.

But there has been a change. The move from Minnesota to the tidewaters of the Chesapeake Bay couldn't help but arouse my interest in what Henry Lyman, editor of the *Salt Water Sportsman,* calls the "Growing Giant"—marine sport fishing. And this interest was much more than professional. Having spent most of my vacation time in the last fifteen years fishing in the best fishing waters of the Middle West, I naturally did a little exploring when I moved east, and I liked what I found. I have a hunch that my future fishing vacations—and what is a vacation without fishing—will be on salt water.

The beginning of salt water angling for pleasure is lost in antiquity, but it must have begun about the time someone got enough food ahead so he didn't have to fish. He just went out and fished for the fun of it. Back in the 1890's when the U. S. Fish Commission's scientific expedition took the first *Albatross* into the Pacific islands, they found some of the natives fishing patiently for hours with hook and line, apparently because they liked it, for they also had fish traps and nets. The accounts of the scientists themselves, though somewhat restrained, sometimes sound as though some of their "collecting of specimens" with hook and line was as much fun as duty.

Large-scale salt water angling doesn't have a very long recorded history even in the United States where it is probably more important than any place else in the world. Just ten years ago a couple of biologists who surveyed the sport fishery of the Middle Atlantic bight said in their report that "twenty years ago there were practically no facilities for ocean sport fishing"—and this in the most densely populated section of our country. During that twenty years previous to 1948, a fleet of about 1,000 charter and party boats had been built up in the New York City, Long Island, and New Jersey area. Since that time the number of boats, trailers, and outboard motors sold in that area, and for that matter all over the United States, is hard to believe.

I don't propose to quote a lot of figures to you about the investments in boats and facilities, numbers of fishermen, or isolated catch statistics. The ones I have seen are large and growing, and of course none are more impressive than right here in Florida. Rather than figures I should like to talk a little about marine

fisheries research and whether we know enough about marine fisheries biology to do a good job of recreational fisheries management.

As a starting point I looked over Bigelow and Welsh's classic "Fishes of the Gulf of Maine," published in 1925. The book contains a wealth of drawings and material on description of the fish, including color and size; general range; habits; food; breeding; and importance. But the phrases "Little is known . . ." or "Nothing is known . . ." or "No definite information is available . . ." are common throughout, even for fish like mackerel, bluefish, striped bass, tunas, swordfish and sea trouts. So then I turned to the 1953 edition, completely revised and with much new material. It was good to read such phrases as "It has been learned since the first edition that . . ." and "recent observations have shown . . ." but still for many of the most important marine gamefishes "little or nothing is known" still about such basics as rates of growth, migrations, maturity and spawning, relative abundance, fluctuations. If we in the Bureau of Sport Fisheries and Wildlife knew as little about ducks and geese—where they winter, what routes they travel and when, we'd be in truly bad shape. And yet the crying need in the field of migratory bird management is for more basic knowledge. Most of our troubles in this field—and we have some serious ones—stem directly from the fact that we still don't have the right answers or enough of them.

I am informed that in the past few years some important contributions have been made to our knowledge about striped bass, that much publicized fish of the Atlantic coast and San Francisco Bay, and about shad, sailfish and swordfish, but I don't think the full recreational potential of the marine fishes can begin to be realized until we know much more about the fishes which we, as fishermen, want to catch. Marine problems, to me, seem much more difficult to solve than those found in fresh water, but certainly the answers are there if we will but expend the effort to find them. It is a vast area we are dealing with. Many people have a feeling that you can't do much about the sea or the fish in the sea to improve fishing. Conservation and management of mixed fisheries involving many species is very complicated. Untangling the web of action and interaction in the big, dynamic sea is going to be tough. Migratory species which ignore the territorial limits of the states or even of the United States make rational management a real problem for the individual state. And oceanic research is expensive.

I think I have detected a certain widespread complacency on the part of salt water anglers and some biologists and administrators. This is understandable, if not acceptable. No license to buy, no seasons or creel limits or restrictions on tackle or bait or places to fish or sizes of fish to keep! All the fun and no responsibility! Where else is such freedom possible? And then when fishing isn't so good in a favorite spot, there are plenty of scapegoats—pollution is always a good one, but blaming the commercial fishermen for tearing up the bottom, catching baby gamefish or catching too much of everything is very popular, too.

The concept of the inexhaustibility of resources has been pretty thoroughly exploded during this century in the United States. The pioneers and early settlers apparently thought there was so much of everything that the idea of husbanding what they found here never entered their heads until they were faced with actual demonstration that resources have limits. I cannot understand how, having rediscovered this truth and having accepted the philosophy of conservation, we can be passive about our ignorance. We ought to demand facts as a

substitute for emotions and be ready to discard preconceptions when we have the facts. We ought to be willing to let tradition go by the board when we find something better.

A fishery biologist a few years ago said that our idea of the sea as the frontier is really the boundary between knowledge and ignorance. Ignorance in the past has led to many unnecessary arbitrary restrictions and regulations governing fresh-water fisheries. Many are still on the statute books; ignorance in the future can do the same for marine fisheries, especially near the shores.

I don't like to keep on harping on this theme of ignorance but we are going to have to get more answers and get them soon. This marine fishery recreational industry is growing like a walleye in a minnow pond. Population pressures and shrinking of inland fishing opportunities are pushing people to the coasts for recreation. Eighty-five million, or half of our human population, live within the states bordering on salt water. The big new highway program makes it easier and quicker for them to get there. Even in the Middle West there is an ambitious program to build a superhighway down the Mississippi River from Minnesota to the Gulf; this sort of thing will be fine for the business end of marine sport fishing, but no business is in good shape without continuing inventories and protection of the sources and supply of raw material.

In September, the Atlantic States Marine Fisheries Commission, representing all the fifteen coastal States, issued a supplement to its annual report entitled "Important Fisheries of the Atlantic Coast." This is a summary of knowledge about twenty-three important species of migratory fish, and importance is determined from statistics of pounds landed by commercial fishermen and the price paid the fishermen for them. Many of the species described are probably as important, perhaps more so, for angling. Many of the important game fish like tunas, tarpon, sailfish, marlin, snappers, snook, and others are not listed at all.

In the supplement I read that sport fishing is gaining in popularity along the Atlantic coast, but the total catch and value of the sport fishery is unknown. I noted that almost nothing is known of the biology of the king and Spanish mackerels. The biologists point out that the croaker is notably erratic, fluctuating between periods of scarcity and plenty. They say large numbers of small grey sea trout are killed in trawls, pound nets and seines and this *may* be an obstacle to the well-being of the fishery. Very little is known about scup and the same story goes for bluefish. Even for striped bass they say "information is by no means complete."

A little stock taking shows that sea fishes are characteristically unstable in abundance but that their fluctuations, though probably predictable, are unpredicted. We see that not even the barest statistics of angler catch are collected except in a few isolated and special places. Apparently there is no reasonable basis for comparing commercial and sport catches or values, much less for evaluating the impact of all fishing on the populations. A great deal is being said nowadays about the remodeling of the inshore areas by real estate promoters, channel dredgers, and others, and about the huge quantities of agricultural chemicals which are being spread about and draining off into the estuarine waters. But there really isn't very much to go on so far as documentation of estuarine use and dependence by gamefish and their tolerance to anything from mild to drastic changes.

I'm not singing this tune over and over to suggest that we need more knowledge to regulate and restrict. Rather, we need it so that we can make wise de-

cisions about management. I'm an optimist by nature, so I'm not trying to scare or suggest doom and depletion—just urging the very widest possible understanding of our present situation in relation to a very big resource.

It has been fascinating to watch the development of the big deep sea fishing rodeos which have become traditional in many ports. Thousands of people from sub-teens to octogenarians bring in everything from three-pound bluefish to 460-pound marlins and have a wonderful time doing it. I think these suggest at least what the recreation potential is: it is many more thousands of anglers of both sexes and all ages, fishing out of every coastal port, renting small boats or chartering large ones or boarding party boats, bringing in their own rigs on trailers and needing launching ramps, food, lodging, fuel, bait, gear, and services in astonishingly increasing quantities. It is greater and greater pressure on the fish populations. It means more, not less, competition with commercial fishermen for fish, for space to fish, and for shore services. It means more need for wise conservation policies and constructive management activities. It means more expenditures of money in the coastal communities and it means more expenditures by conservation agencies.

—And that last statement naturally leads into the matter of license revenue from salt water anglers. I know how controversial this subject is, but I rather believe that most anglers would not oppose a reasonably-priced license if they could be shown how they would benefit. What are some of these benefits? Licensing would make the collection of catch statistics easier and these are important to biologists and conservationists, but the sportsman will have to be shown how these data will benefit him. The Sport Fishing Institute has assembled some illustrations of how useful construction of artificial fishing banks has been in a few areas. Other salt water fishing services which only public agencies can provide for everyone will have to come from revenue—and I suspect it will have to come from revenue provided by the salt water angler. Research and action programs for the prevention, control or abatement of pollution, including the new hazard to fish and fishermen of radioactive waste disposal at sea, will be increasingly important to salt water anglers. Research on the effect of the rapidly expanding chemical pesticide program on our estuarine spawning grounds may become all important. Research to define good fishing grounds, to explain and predict fluctuations in abundance and distribution of important species from year to year and place to place, to divert fishing intelligently to other species and other areas when abundance or availability are low, and to formulate rational conservation measures when they become necessary. And I probably don't have to add that research on a scale necessary to produce useful and full information is likely to be very expensive. I have said enough about licensing at this time but the money is going to have to come from somewhere. We are going to have to have the answers if the marine recreational fishery is to be properly managed, and this nation cannot afford to have it mismanaged. We have here an opportunity to profit from past mistakes in inland fishery management. The crime is not in making mistakes but in the failure to learn thereby.

In closing, I want to refer back to the title of this paper, "The Recreational Potential of Marine Fisheries." What does it mean? It means many things to many people. It is wholesome use of leisure time for hordes of harassed Americans wearied by the too-fast pace of modern living and world tensions. It is an economic heaven-on-earth for manufacturing and service industries. It is a

challenge to conservationists and researchers, and it is a challenge that must be met.

Canning Tuna in Puerto Rico

ROLF JUHL

Fleet Operations Manager, Van Camp Seafoods Co., Inc.
Ponce, P.R.

THE CALIFORNIA TUNA INDUSTRY dates back to 1903 when failure of the pilchard fishery inspired a resourceful packer to try packing albacore in an effort to keep the cannery in operation. After a few years of experimentation the new white meat tuna pack received acceptance and by 1914 over 200,000 cases reached the consumers' market. In 1915 canneries had started canning skipjack, yellowfin and bluefin.

The tuna fleet kept abreast of the growing demand for this new fish product and changed from the small forty to sixty feet ice boats to the present modern clippers with capacities up to 600 tons and cruising ranges of 10,000 miles.

Over the years the tuna industry went through various upheavals and reverses. The first and second World Wars helped to increase the domestic production from 200,000 in 1914 to 1,000,000 cases after the former war and from 4,000,000 to 6,000,000 after the latter. The present domestic catches have stabilized around 300,000,000 pounds per year yielding from forty to forty-five million dollars to the fishermen.

Most of the larger canners of the West Coast combined tuna and pilchards as the production mainstay. In 1952-53, when the California sardine fishery collapsed, many of the West Coast canneries could not survive on tuna alone. Many packers closed their doors and others moved their operation to more favorable locations. This decentralization opened canneries in Peru, Ecuador, Puerto Rico, and in remote Samoa. The Puerto Rican cannery commenced production during the later part of 1953, and has always depended on the clipper fleet for its fish. The lack of market outlets, limited fishing fleet and other factors made it an unprofitable venture for the original owners, and in 1956 was sold to Van Camp Sea Food Company of California.

The National Packing Company cannery, located in Ponce, Puerto Rico, has several advantages over stateside canneries. It affords a closer market to the East Coast of the United States than California, cheaper labor, lower freight rates by sea as compared to rail freight across the United States, tax exemption grant under the Puerto Rico Industrial Development plan and shorter distance from the Eastern Central Pacific fishing grounds to Puerto Rico through the Panama Canal than to California and North Western ports. Conversely, the disadvantages in having a cannery in a practically isolated geographic area include lack of trained personnel, lack of services and supplies for a new industry, poor harbor and docking facilities for the tuna clippers, hazardous ocean crossing of the Caribbean, and reluctance of experienced key administrators and technicians to take jobs in another country.

Since its inception in 1953, National Packing Company has increased its daily production in Ponce from 15 to 100 tons and lengthened the yearly packing period from six to nine months. When Van Camp took over the plant major

expansions occurred. Production increased from 40 to 100 tons per day and the fleet was augmented by five ships, with intentions of adding at least three others to make a total of twelve or thirteen vessels. Additional foreign fish imports supplement the Company's fleet landings.

Fishing Operation

A fishing trip for one of the Puerto Rican clippers involves more preparation than any other fishing vessel except those in the whaling industry. These ships may be out from two to four months before returning to their home port; a complete set of spare parts for all engines and special equipment must be carried, and 30 to 90,000 gallons of diesel fuel plus supplies and provisions to last throughout the trip are loaded before departing.

From Ponce or San Juan, the boats proceed across the Caribbean through the Panama Canal. At Balboa, after incidental supplies are taken aboard, the ships sail for the bait grounds. If the captain plans to fish in warm water (75-85°F), baiting will be done in the Gulf of Panama area for anchovetta *(Cetengraulis mysticetus)* which abound along the coastal waters and exhibit ideal characteristics for bait tuna fishing. After filling the ships' bait tanks and wells with 2,500 to 4,000 scoops, (an equivalent of twelve to twenty tons of anchovettas), the clippers sail for the tuna fishing areas. This encompasses the off-shore waters between the Gulf of Guayaquil and the Gulf of Tehuantepec for our fleet. Whenever the captain decides fishing is better farther south or off the Galapagos Islands, he will take the ship directly to either of these localities and follow the same baiting procedure. In this case, anchovy, *Engraulis* sp. and sardine, *Sardinops* sp., are commonly taken.

Upon reaching tuna areas, a sharp lookout is kept for signs of yellowfin tuna *(Neothunnus macropterus)* and skipjack *(Katsuwonus pelamis)* which may be located by breezing schools (slow moving aggregate of fish just under the surface), jumping porpoises traveling with tuna, or birds working over feeding fish. While looking for tuna, a feather jig may be trolled in an attempt to discover possible schools not showing on the surface.

When a potential biting school is sighted the captain will approach it by whatever technique may seem more desirable, the chummer (in charge of the live bait to be used to attract and hold the tuna or skipjack) will commence throwing bait over the side, and the fishermen will concentrate on hooking the fish which strike their feather lure (squid) fixed with a barbless hook. Since the bamboo poles used in this bait fishery have a six to seven feet overall line and leader tied to it, a man ca nswing the fish over his shoulder without undue strain or loss of time, and a considerable amount of fish can be landed in a short time. The barbless hook makes unnecessary any handling of the tuna to remove the hook. If the fish are particularly large, two or three men will work as a team on one hook. A size classification of tuna is made by stating the number of men fishing one hook; one pole tuna—up to 35 lbs.; two pole tuna—35 to 60 lbs.; three pole tuna—60 to 100 lbs.

If the school stops biting or too many fish accumulate on the deck, the men will put the catch in the freezer wells for initial chilling with refrigerated sea water. Complete freezing follows with concentrated brine, which is pumped overboard after reaching a temperature of 19 to 20°F. The fish remains in dry cold storage at approximately 5°F until unloaded.

An average trip for one ship includes various visits to the bait grounds and to

a coastal port, generally Panama in the central area and if fishing farther south, Talara, Chimbote or Callao, for replenishment of fuel and supplies. The loaded clipper will then enter Balboa, drop some fishing gear and supplies, and proceed for Ponce, Puerto Rico, via the Panama Canal.

Unloading and Processing

In Ponce the ship loads salt to thaw the fish for unloading. The method followed is the reverse of the freezing operation: concentrated brine is circulated through the wells until the fish reaches 26° or 27°F, a temperature adequate to permit evisceration and still keep the fish firm enough to prevent breakage while discharging. The tuna is taken to the plant in specially designed carts, where it is weighed and emptied on to conveyor-type butchering tables for gutting and cleaning. The clean fish are placed in baskets and racked according to size and wheeled into pressurized precookers, then steamed at temperatures ranging from 216 to 218°F for one to eight hours, depending on the size of the fish, which ranges from five to eighty or ninety pounds. After cooking and cooling the tuna are cleaned, and the four main longitudinal muscles, or loins, are canned after passing through a chopper or mechanical former. Oil and salt are added, after which the cans are sealed, washed and cooked under pressure of 15 pounds per square inch at 240°F. After the cans have been removed from the retorts and cooled, they are labeled and cased, and the pack is ready for shipment to the East and Gulf States.

Future Outlook of the Tuna Fishery in the Caribbean and Atlantic

From time to time, since 1950, various attempts have been made by private, federal and foreign agencies to determine the potential tuna fishery in the Caribbean and adjacent Atlantic waters. These attempts have shown limited success except for the present Japanese endeavor. The extensive Japanese longline fleet operating in the Caribbean and Atlantic, upward of sixteen vessels, is proof enough of the rich tuna fishery available in these waters. Undoubtedly their initial trials would not have been possible without substantial aid from the Japanese Fishery Ministry. Also, the knowledge and experience of the Japanese on this type of fishery gives them a great advantage in exploiting this natural resource.

Gauging the population of subsurface tunas by the Japanese landings, a comparable stock should be available on the surface for a pole fishery, assuming, of course, that the Atlantic fish follows the same pattern of behavior as those in the Pacific. Pacific tuna often feed near the surface during the earlier stages of their development and follow deeper ocean currents at later stages. During the former stage the fish are available to the pole fishing boats, and during the latter to the longline vessels.

The increased demand for canned tuna and tuna-like fish in the world market has broadened the fishery to an extent where a much greater interest has been shown in the exploration and exploitation of formerly unfished oceanic and coastal areas. The Japanese, through government aid, have a unique advantage in low operation costs and broad experience in longline fishing and lead the world in exploratory fishing and as tuna suppliers. Ports of the Caribbean Sea and neighboring waters may soon be developed into a Pacific-type tuna fishery, but a combined and cooperative effort by participating governments and private concerns in this area would hasten the verification of the fishery potential and simplify its development.

A long range program to establish a tuna fishing industry requires planning and services similar to those of the Pacific Coast, including:

1. Training program for local fishermen.
2. Adequate baiting facilities.
3. Accurate plotting of fishing banks and recording of seasonal variation in abundance and locality.
4. Studies of ocean currents as an aid for fishing and navigation.
5. Establishment of reciprocal customs port entry requirements, regulations, etc., between participating governments for the fishing vessels.
6. Forming a control organization for collecting and disseminating information.
7. Installing adequate freezers for collection and distribution of fish.

The pioneering aspect of this project may seem complex, but the comparatively close association with the Pacific fishery and world interest in tuna should be an excellent source of information and assistance for its initiation.

BIBLIOGRAPHY

Anderson, A. W., et al.
1952. Survey of the Domestic Tuna Industry. Spec. Sci. Rep. U. S. Fish Wildl. Serv. (Fish.) No. 104.

Anonymous
1944-1957. Tuna. Pacific Fisherman Yearbooks.

Schaefer, Milner B.
1957. Utilization and Conservation of the Tuna Resources of the Eastern Tropical Pacific Ocean. Trans. N. Amer. Wildl. Conf. (1957).

Tressler, D. K. and J. McW. Lemon
1951. Marine Products of Commerce. Reinhold Publishing Corp., New York.

Haiti's Fisheries and Their Potential Development

Martin H. Routh
Fisheries Officer, Food and Agriculture Organization, Port-au-Prince, Haiti

In 1954, following the missions of two FAO fish culture experts to Haiti, during which much was done to establish fish culture in the country, the Haitian Government requested FAO's assistance to survey her existing fisheries, potential fisheries resources, and to advise and assist her in formulating and implementing a fisheries development program. In May, 1955, the writer arrived in Haiti to carry out this assignment.

The basic economic reasons for this request are clear. Haiti imports each year some 15,000,000 pounds of salted and smoked herring and cod, mostly

from Canada, worth nearly $1,500,000 CIF, which she can ill afford. At the same time her existing fisheries are in a very primitive state, and those employed in them operate at subsistence level. Any development in her indigenous fisheries would thus have the merits of reducing the flow of money from the country, improving the economic position of the country's fishermen, and, as the standard of living rose, of increasing the consumption of animal protein among the peasant population.

The first months in Haiti were spent travelling around the coasts, visiting the fishermen's villages. These journeys were made either by truck, by boat, on foot or on horseback. Besides making a census of the fishermen, their boats and gear, an appreciation was gained first hand of some of the physical factors, such as the prevailing wind and sea condition, and the coastal geography which controls what operations are possible. Some parts of the coast, for instance, are fringed by impassable reefs, others are bounded by continuous cliffs; in other places there are excellent harbors, and many open, sandy beaches are to be found. Sea conditions off the north and south coasts are generally worse than in the Gulf of La Gonave to the west of the island, since they are open to swells which reach them after uninterrupted passages across wide stretches of ocean. The sea conditions all around the island are influenced by the normal on-shore, off-shore cycle of winds caused by the daytime heating and night time cooling of the air over the land. The fishermen use the off-shore morning breezes to sail to their fishing grounds, and the on-shore afternoon breezes to return.

Internal communications in Haiti are slow. Few surfaced roads exist, and rains frequently temporarily cut off one from another. This, combined with the low purchasing power of the peasant farmer and his taste for salted fish, point to improved salting methods and perhaps the introduction of smoking as the most suitable preservation methods at this time, except in the very few towns where ice making plants exist. At present, a high proportion of fishermen fish primarily for their own needs and those of their families. Any surplus is bought by travelling saleswomen, known locally as Madam Sarahs, who salt it lightly with impure locally produced salt, partly dry it, and carry it a few miles inland, usually on donkeys, for resale. This fish normally keeps for about three weeks. Sometimes a load is carried to a market center like Port-au-Prince, where it sells for about 10 per cent more than it will bring in the country. The high prices paid by the very poor peasants for imported salt-fish are surprising ...herring 22c-25c per pound, and cod 25c-35c per pound... until it is realized that these fish are used not so much as an article of nourishment, but as a condiment with the salty or smoky flavor being imparted to the whole family's dish of rice.

The Haitian fisherman's gear is extremely simple. His boats range from "pri pris" through dugout canoes and flat bottomed "corallains," to twenty foot sailing boats. The pri pri is a simple wooden raft, sometimes made of bamboos lashed together, sometimes of more substantial logs, sometimes paddled, sometimes sailed with the aid of an old flour sack. It is almost certainly a direct descendant of the original Indians' rafts which were called pipirites, the word having now become corrupted into pri pri in the north and piri piri in the south. The typical sailing boat is carvel built, and is normally of very rough construction. This is due more to the quality of the materials which are available and the limited purchasing power of their clients than to lack of skill

in the shipwrights. Some of them make a very creditable boat considering the tools at their disposal, but this is not to say that there is not considerable room for improvement in the over-all standard.

Of the various fishing methods employed, hand lining is the most common. Longlines are also known, but although very effective, they are not very widely used owing to the risk of losing a considerable sum of money at any one time. Independently floated lines up to about one foot in length are also used for taking needlefish (*Ablennes hians*) at the surface. Lines are also trolled by fishermen on their way to and from their grounds but this is not regarded as a very profitable method of fishing and is only carried out incidentally. Trap fishing is the second most important fishing method. The typical trap is Z-shaped, is made of woven split bamboo and has two entrances. This type of fishing, of course, is popular since it does not demand a high expenditure of energy and leaves the fisherman with the maximum time for other pursuits such as tilling his plot of land. Most fishermen are, in fact, part-time farmers who go to sea to add a bit of variety to their menu. Traps may be baited or not, depending on the whim of the owner; the bait ranges from sour oranges to fish, and sometimes crawfish. The latter are not much prized by the fishermen who prefer scale-fish, and when crawfish are taken, as sometimes happens, they may well come to this ignominious end. Shore seining is also an important fishing method, but it is limited in application. It is often carried out by nomadic groups of fishermen who erect temporary huts on the beaches and salt the major part of their catch. Shore seines are made of cotton, which is only rarely treated against rotting. Tar is the only preservative in general use. Under these conditions the webbing lasts on the average only about three months. Since shore seines may cost up to $200 when new, and the catches are small, there is small wonder that the price of fish to the consumer is high and the fisherman's profit low. The only other type of net in use is the cast net, which is widely used in shallow waters. While many fishermen know how to make a net, it is of interest that very few can repair one correctly. The only other type of fishing gear which is remotely important is the spear. Harpoons are used for taking sharks off the entrance to the Artibonite River, and crawfish are sometimes speared after being attracted to a torch at night.

In summary, there exists a very simple, badly equipped, fishery around the coasts of Haiti, operating at peasant level from sailing and rowing boats. It is prosecuted by between 7,000 and 8,000 fishermen, two-thirds of whom perhaps are part-time. Their equipment is limited in type and expensive, especially in the country districts where fish hooks may cost up to fifty times their f.o.b. price. This is due partly to bad communications and partly to high taxes. Fish preservation methods are bad. These considerations taken together spell small profits for the fishermen and high prices for the consumer.

How should the problem of developing these fisheries be tackled? It seemed that dual approach was needed; on the one side to encourage private enterprises, using as high a proportion of local fishermen as possible to undertake the comparatively large scale operations, involving powered boats which are necessary to tap high seas resources at present untouched by the peasant fishermen; on the other side to improve the fishing techniques and equipment of the indigenous fishermen, and to improve their fish curing and marketing facilities.

During the initial survey, on many occasions shoals of bonito or skipjack

(*Katsuwonus pelamis*) and albacore (*Thunnus atlanticus*) were noticed feeding at the surface. Although the local fishermen do not catch these fish, they form the basis of a prosperous industry in Cuba, where some 12,000,000 pounds are landed annually by a fleet of between thirty and forty boats using the pole and line method. There seemed, *a priori,* no reason why such an industry could not be established in Haiti, using partly Haitian and partly foreign crews. Since, from a nutritional point of view, the establishment of such an industry would be likely to give quicker returns than extension work among the local fishermen, it was decided to concentrate on this at the start.

In order to encourage potential investors in such an industry, it is necessary first to demonstrate that the fish can be caught, second that they can be caught, prepared and sold on a commercial basis. In order to test if this could be done, the Haitian Government, at FAO's suggestion, chartered the Cuban bonito boat *Santonia* in the spring of 1956 from Messrs. Mariscos del Caribe, with a skeleton crew of three. For three months she worked around the coast of Haiti and the distribution of tuna, and their proximity to available live bait at that time was plotted. Considerable concentrations were found off the northwest tip of Haiti, off Jérémie at the tip of the southern peninsula, and off the southwest coast from Aquin to Coteaux. In view of the lack of good harbors on the south coast, east of Aquin, and the fact that large concentrations had already been found, the remainder of the south coast was not investigated although there are strong reasons to believe that tuna would be found all along it, particularly in the area east of Saltrou, behind Beata Point. Minor concentrations were also found regularly off Miragoane, halfway along the north coast of the southern peninsula, and off the west end of Ile de la Tortue. The local fishermen claim that bonito occur at these places throughout the year, and experience confirmed that they could be found for at least eight months, from the start of our operations in February to their end in September.

The initial findings were encouraging, especially in view of the subjective opinion of the Cuban fishermen that there were as many, or more fish in these areas than on their home grounds. It was therefore decided to continue the charter of the boat for a second period so that commercial trials could be carried out. The base chosen for these was Môle St. Nicolas, a magnificent natural deep water harbor at the northwest tip of Haiti. Bait fish are plentiful in the bay which is situated in an arid area excellent for salting and drying, and so close to the fishing grounds that bonito could often be seen from our anchorage leaping in the bay itself. Unfortunately, these trials did not start until mid-August, near the end of the high season as experienced in Cuba. In spite of this, and the fact that there was a skeleton crew of only four Cubans aboard, supplemented by inexperienced Haitians, (who, incidentally, made considerable progress as time went on) the *Santonia* still took an average of nearly half a ton of fish a day during the month under trial. This is about the same as she averages at the height of the season on her home grounds with a full Cuban crew, a remarkable achievement due largely to the proximity of the grounds to the base of operations. A simple open-sided drying shed was built, and local women were taught to prepare and salt these fish with high grade fisheries salt imported from the Turks Islands. The results turned out very well, some samples being eaten more than six months later. The sales trials showed that, although it was a new product, it was well received.

At the end of the trials, a prospectus was drawn up showing the approximate

returns to be expected on an investment in a fishery of this sort, based on local sales of dried salted fish. The use of foreign technicians was envisaged in the key positions aboard, at least at the start, coupled with Haitian labor. The prospects seemed good even when contemplating starting operations with a fleet of only three boats. It should be remarked that the fishing boat design section of FAO's fisheries division has designed a boat specially for near water pole and line fishing out of Haiti, based on our experience. It should, of course, be borne in mind that the local market is not the only one available. There is now a tuna cannery in Puerto Rico which would probably be glad to take the higher grades of tuna, so a dual outlet might well be anticipated.

During our trials, the albacore (*Thunnus atlanticus*), which is a light meat tuna, was by far the commonest species taken, with skipjack (*Katsuwonus pelamis*) second, and yellowfin tuna (*Thunnus argentivitatus*), Atlantic little tunny (*Euthynnus alleteratus*), and frigate mackerel (*Auxia thazard*) also taken.

Unfortunately, the year following these trials proved to be one of great political instability in Haiti and this has discouraged investors. There are hopes now that an industry of this type will soon be established, but there is certainly room for more than one operator, and the prospects merit close attention.

The Haitian Government has only recently been able to turn its attention to the other potential line of development, that of improving the techniques of its indigenous small fishermen. In this respect it was first necessary to set up a mechanism through which this could be done and to deal with some fundamental problems. It has recently passed legislation establishing, for the first time in Haiti's history, a Fishery Service responsible for both inland and marine fisheries development. It has the right to operate a revolving fund for the purchase of high quality fishing gear for resale at minimum prices to fishermen through shops to be opened in coastal districts. These shops will be able to sell gear on a supervised credit basis. The Service thus has powers with which to face the basic problem of getting better equipment into the hands of fishermen who live far from shops and whose cash resources are meager. A certain amount of gear has already been ordered, so a start has been made. Again, the government is taking measures to eliminate taxes on fishing gear, an essential preliminary to the introduction, for example, of nylon, which up to now has carried a tax of 40 per cent ad valorem.

It is intended to train extension agents who will work for the Fishery Service, operating from centers to which these stores will be attached. Their main work will be the training of local fishermen, but they will also carry out some exploratory and experimental fishing. The Service also intends to teach better salting methods and to organize better distribution facilities.

What are the main unfished or under-fished resources, and what new types of gear is hoped to introduce to tap them? A complete answer, of course, is not possible, but work carried out so far points to some possibilities. After the tuna, the next most important group are perhaps the semi-pelagic shoaling fish, and of these the blue striped cavalla (*Caranx ruber*) known locally as the "carengue fine" is perhaps the most important. Dense shoals of these fish are frequently seen near shore throughout most of the year, and especially in the summer. They have been taken in trammel nets and would be likely to be taken in surface set gill nets. They have also been attracted to lampara nets at night and might be susceptible to being taken with encircling nets or lift nets. The yellowtail (*Ocyurus chrysurus*), another shoaling fish, is taken by hand

lines at night. The introduction of monofil nylon lines, and of wire lines in conjunction with hand reels, would improve the rate of fishing for these fish and for snappers which are taken at great depths by day. Deep water handlining results in the capture of some fine fish, but cotton lines are often lost to large fish and sharks. It is believed that the introduction of wire will greatly reduce this loss. Bottom and surface set longline gear will also be tried. Nylon trammel nets have proved very efficient for a wide variety of species, and local fishermen to whom some were loaned soon learned to use and appreciate them, making, for them, unprecedented catches. Gill nets are also likely to be effective for many species and will certainly be tried both at the surface and the bottom. Trammel nets are one answer to the problem of reef fishing. Set around the reefs they have taken a wide range of scale fish at night, when many fish apparently leave the shelter of the reefs. They are also effective for crawfish. Trials are also envisaged with traps woven from wire rather than the weak bamboo traps presently in use, and it is hoped that improvements will result.

These are, of course, only some of the main types of gear that it is hoped to popularize, but even so, their introduction among the small fishermen will take time and patience. Hence, the new Fishery Service has much to do to encourage and assist the development of Haiti's fisheries both on a comparatively large scale and among the peasant fishermen. There is still a long way to go before it can be said that Haiti's marine resources are being fully exploited, but there is no doubt that the seas around Haiti can produce much more than at present to feed her population. A start has now been made on this work—let us hope that it will be energetically and successfully followed up.

Experimental Trawling for Red Snapper

Warren F. Rathjen

Fishery Methods and Equipment Specialist U. S. Fish and Wildlife Service
Pascagoula, Mississippi

The commercial fishery for red snapper in the Gulf of Mexico is carried on almost exclusively by handline operations. In many instances during recent years the fishery has taken advantage of electronic devices such as loran and depth recording equipment. The use of mechanical reels is now widespread in the red snapper fishery. The basic approach to the production of red snapper, however, has remained essentially the same during the past century, in that the hook and line method of fishing accounts for practically all of the present catch.

There have been numerous attempts to develop methods other than the handline by which red snapper could be taken in quantity. It has been recognized that the use of other types of gear in the fishery might be desirable.

Attempts by various workers have dealt with the experimental use of traps and trawl lines (Jarvis, 1935); hoop nets and mechanical reels have also received attention (Smith, 1948; Siebenaler and Brady, 1952). In some cases, the results of these experiments have stimulated further consideration regarding use of gear other than the handline in the fishery. Experimental fishing with

traps carried on recently has included the use of underwater television for the purpose of observing the reaction of fish to the traps, thereby improving the efficiency of trapping gear (Marshall, 1958).

Until the present study, little effort had been made to utilize trawling as a method of catching red snapper. For the most part, it was not considered practicable to use trawls on the hard and often ragged bottom where snapper are commonly found. That red snapper could be taken with trawls has often been demonstrated by shrimp fishermen who, on occasion, take up to several hundred pounds during short trawl drags. These incidental catches of snapper taken in the shrimp fishery often result from trawling over or adjacent to rough bottom or wrecks which are ordinarily avoided because of the danger of damaging trawls.

Early in 1957, the Bureau of Commercial Fisheries initiated a study to use in the Gulf of Mexico, fish trawls developed for trawling on rocky bottom in the North Atlantic ground fish fishery. This gear differs from conventional shrimp trawling rigs in several respects. The foot rope is protected by wooden rollers up to twenty inches in diameter. Large bracket doors are used which are attached to the trawl by 10 - 30 fathom ground cables or "legs." The nets used in the present study were constructed from braided nylon, four and one half inch stretched mesh size. Heavy cowhide is attached to the bottom of the bag of the net to reduce the effect of chafing. This type of gear has proved to be effective in working over hard bottom in the Gulf; occasional damage to the gear has been limited to small tears which were readily repaired. In the early stages of the study trawls constructed of manila were used, but these were easily torn and required more maintenance than the trawls constructed from braided nylon.

In the Spring of 1957, the M/V *Silver Bay* was chartered to supplement the operations of the Service's M/V *Oregon*. The *Silver Bay* is a New England style beam trawler of steel construction, ninety-seven feet in length and is rigged with fore and aft gallows. The vessel is equipped to handle roller rigged fish trawls.

The program has been divided into two phases. The first phase, extending from the spring of 1957 until October 1958, was devoted to area coverage. Eight cruises were directed primarily toward red snapper trawling. Areas worked include the northern Gulf from Cape San Blas, Florida, to Brownsville, Texas; the eastern Gulf from Cape San Blas to Dry Tortugas, and the northern and western portions of the Campeche Bank area. Effort was mainly concentrated between the depths of twenty and fifty fathoms; limited explorations were carried on in water of less than twenty fathoms and in depths from 50-100 fathoms. Whenever practical the trawling was pursued on "broken bottom," typically consisting of areas of sand and shell with intermittent batches of limestone or coral. On a few occasions drags were made adjacent to snapper "lumps," usually composed of rugged masses of limestone or coral. In attempting to drag close to these lumps the net sometimes hung fast to the bottom. Although most of these did not result in severe damage to the trawl, it was not considered practical to work too close to very rugged bottom. At several locations, particularly off the Texas coast, large quantities of sponge were encountered. The principal problem resulting from these was not gear damage, but the danger of severe skin irritation to the man on deck.

It was not possible to give complete seasonal coverage to all areas in the

Gulf during the exploratory phase. In the northwestern Gulf, exploratory fishing efforts extended throughout the year. In the northeastern Gulf, cruises were completed during late winter and early spring. One cruise was devoted to the east Gulf in late summer of 1958 and Campeche Bank was investigated during a single cruise in spring of 1958.

In the initial or exploratory phase of the study it was desired to define areas of potential commercial importance. In the northwest Gulf best results were experienced in the "Little Campeche" area southwest of Galveston, Texas. One drag here during the first months of 1958 produced about 475 pounds of snapper ranging in size from 1 to 25 pounds. Catches here generally averaged less than 100 pounds per drag. Explorations in the east Gulf did not indicate any locations at which snapper were available to trawl operations in good quantity on a sustained basis. Occasional catches of snapper, of mixed sizes, up to 200 pounds were made in this area.

The most promising results of the exploratory phase of operations were accomplished on the Campeche Bank area during May of 1958. The best catches during this cruise (#8 M/V *Silver Bay*) were made south and southeast of Cay Arcas in 20 - 35 fathoms. In five days of exploratory operations (33 drags) 4600 pounds of snapper and 700 pounds of grouper were taken with the trawl

TABLE 1

WEIGHT TABULATION OF SNAPPER AND GROUPER CATCH FROM *Silver Bay* CRUISE 8.

Species	Common Name	Total Wt.	Average Wt.	Wt. Range
Lutjanus aya	Red snapper	3298*	5 lbs.	1-27
Lutjanus synagris	Lane snapper	1043*	2 lbs.	1-4
Lutjanus analis	Muttonfish	879*	12 lbs.	3-20
Lutjanus cyanopterus	Cuban snapper	55	20 lbs.	15-25
Lutjanus griseus	Gray snapper	30	2 lbs.	1-4
Lutjanus apodus	Schoolmaster	58	8 lbs.	6-30
Lutjanus buccanella	Blackfin snapper	14	6 lbs.	3-8
Lutjanus vivanus	Silk snapper (yellow-eye)	7	7 lbs.	7
Ocyurus chrysurus	Yellowtail snapper	98*	1 lb.	1-4
Rhomboplites aurorubens	Vermillion snapper	60*	1 lb.	1-2
Lachnolaimus maximus	Hogfish	41	9 lbs.	3-12
Epinephelus morio	Red grouper	870	12 lbs.	3-20
Epinephelus nigrita	Warsaw grouper	12	12 lbs.	12
Epinephelus guttatus	Red hind	2	2 lbs.	2
Epinephelus striatus	Nassau grouper	8	8 lbs.	8
Mycteroperca microlepis	Gag	60	8 lbs.	2-16
Mycteroperca phenax	Scamp	143	4 lbs.	3-6
Mycteroperca falcata	Scamp	8	4 lbs.	4
Mycteroperca bonaci	Black grouper	274	15 lbs.	10-30
Promicrops itaiara	Spotted Jewfish	515	257 lbs.	150-365

*Does not include large numbers of less than 1-lb. fish. (*Note:* For the most part, minimum sizes of snapper caught with the 5″ stretched mesh cod end were ¾ to 1 pound. The numerous smaller fish were caught when a 2″ stretched mesh liner was used for sampling purposes.)

in this area. The best individual drag accounted for 870 pounds of snapper and fifty pounds of grouper.

Further explorations on the Campeche Bank were carried on east of the Triangles, two drags resulted in catches of about 250 pounds of red snapper each. Exploratory drags to the north and east across the Bank did not reveal any large concentrations of red snapper. An encouraging feature of the work in the Campeche area was the performance of the gear, which required little attention, although much of the fishing effort was at locations where hard bottom was much in evidence. Occasional hang ups were encountered; however, no serious damage to the nylon trawl resulted. At the locations at which the best fishing was accomplished the depth recorder indicated that the bottom was generally even, with scattered patches of coral or sponge. When a sudden rise was observed on the depth recording apparatus the course of the vessel could usually be altered so that the obstruction could be avoided.

Twenty species were represented in the snapper and grouper catch taken on the Campeche Bank. A breakdown of these by weight is given in Table 1.

Incidental to the catch of snapper and grouper, many other species of fish were taken, including such varieties as porgies, butterfish, croakers and pinfish. Indications from the sampling with roller-rigged fish trawls suggest that this gear may be of importance in fishing for species other than red snapper in the Gulf of Mexico.

The second phase of the present study will be concerned principally with assessing the potential of areas giving good indications of red snapper during the exploratory work. Simulated production fishing was initiated in the fall of 1958 and will continue until the spring of 1959. It is anticipated that most of this effort will be concentrated on the Campeche Bank. The coverage will be pointed toward establishing whether this method of fishing can be pursued on a commercial basis.

BIBLIOGRAPHY

Bullis, Harvey R. Jr.
1957-1958. Cruise reports: M/V *Oregon* Numbers 43 and 44, M/V *Silver Bay* Numbers 1, 2, 4, 5, 7, and 8. U. S. Fish and Wildlife Service, Pascagoula, Miss.

Camber, C. Isaac
1955. A Survey of the Red Snapper Fishery of the Gulf of Mexico with Special Reference to the Campeche Banks. Florida State Board of Conservation, Tech. Ser. No. 12, 1-63.

Jarvis, Norman D.
1935. Fishery for Red Snappers and Groupers in the Gulf of Mexico. U. S. Fish and Wildlife Service, Invest. Rep. 26, pp. 1-29.

Knake, Boris O.
1956. Assembly Methods for Otter-trawl Nets. U. S. Fish and Wildlife Service, Fish. Leafl. Wash. No. 437.
1958. Operation of North Atlantic Type Otter Trawl Gear. U. S. Fish and Wildlife Service, Fish. Leafl. Wash. No. 445.

Marshall, Arthur
1958. Cruise report, M/V *George M. Bowers*, No. 12. U. S. Fish and Wildlife Service, Miami, Florida.

Siebenaler, J. B. and Winfield Brady
1952. A High Speed Manual Commercial Fishing Reel. Florida State Board of Conservation, Tech. Ser. No. 4.

Smith, R. O.
1948. Experimental Fishing for Red Snapper. U. S. Fish and Wildlife Service, Comm. Fish. Rev. 10 (2), 1-10.

Laboratory Experiments on Raising Tilapia mossambica in Salt Water

Jacques S. Zaneveld*
Caraibisch Marien Biologisch Instituut
Curaçao, N. A.

In 1952 Vaas and Hofstede, in their "Studies on *Tilapia mossambica* Peters (ikan mudjair) in Indonesia," state that it is eurythaline and thrives and reproduces equally well in fresh and brackish water up to 30 parts per thousand salinity. From 30 parts per thousand to 40 parts per thousand its growth is satisfactory, but it does not reproduce.

The Leeward Islands of the Netherlands Antilles in the southern part of the Caribbean Sea are semi-arid and no fresh water ponds occur there, except temporarily. They are, however, provided with a great number of fairly large salt water inland bays with many arms. These bays are connected with the sea by a small entrance blocked by a bar. Remembering the brackish water fish ponds in Indonesia, called "tambaks," these West Indian bays seem well accommodated for the introduction and rearing of *Tilapia.*

It is highly desirable that a new source of cheap proteins become available to the inhabitants of these islands. Curaçao, with an area of 424 square kilometers, already has a population of 120,000. Moreover, there is a lack of bait fish. Both problems would be solved at the same time if *Tilapia* could be introduced into these bays and would be able to maintain itself.

The inland bays have a temperature varying between 26° and 34° C and a salinity from 36 parts per thousand to 40 parts per thousand. They have an area of one to two square kilometers and a depth of six to eight meters. The bottom is muddy, and sea grass and sea weeds grow along the borders. In the rainy period (November to March) humus from the island is washed into the bays. This may help in the production of bottom algae needed by these fishes.

Because of the high salinity, and with regard to the experience cited by Vaas and Hofstede, it appeared to be necessary before stocking a bay with *Tilapia* to carry on some laboratory experiments on its propagation in water of high salinity. By courtesy of Mr. H. W. Lyding, head of the fisheries in Surinam, on May 17, 1957, eleven *T. mossambica* were taken to Curaçao in plastic bags filled with rain water. All specimens arrived safely, and were placed in aquaria with fresh water, at a temperature of from 27° to 28° C. On June 10th, about 40 young were born. On August 11, ten specimens of this first generation to be born in Curaçao were put into a separate fresh water aquarium, through which a continuous flow of a mixture of fresh and salt water, in the proportion

*Paper No. 13 from the Caribbean Marine Biological Institute, Curaçao, N. A.

3:1, was run. After 48 hours the salinity appeared to be constant. After ten more days, more salt water was gradually added to the mixture until the salinity remained constant at 20 parts per thousand. In the aquarium containing this water, twenty-four *Tilapias* were born on October 4. Only nine specimens survived. Four of these were separated into an aquarium (100 x 50 x 60 cm) with running sea water (salinity 36.2 parts per thousand, temperature about 28° C). In this aquarium the fishes became adapted to their new food, marine algae (*Enteromorpha intestinalis, Cladophora* sp.) instead of fresh water algae. This did not seem to affect the fishes in any way, and their growth was equal to that of fish in the fresh water aquaria. In due time a male got its sexual coloration and started digging a nest. On December 9, a female showed the thick throat indicating that she had the eggs in her mouth. By December 14, twenty-one young had lost their vitelline vesicle and were swimming around in the sea water.

Since that time they have been spawning regularly in sea water at intervals of from twenty-eight to fifty days. This is normal sea water from the Caribbean Sea, flowing constantly through the ducts of polyvinylchloride and then wasted. The housing of the centrifugal pumps is of polyvinylchloride so that the sea water does not come into any contact with metal. The used sea water can be allowed to run to waste because the Institute is so close to the sea that no reservoir is needed.

So far the number of young born in sea water has never been greater than twenty-five. The size of the fish in the aquarium remains rather small, ten to twelve cm maximum, even if only one, two or three specimens occupy an aquarium of the same size. The same number of *Tilapia* raised in a bigger aquarium grow larger, so it appears that it is not only amount of food which determines the maximum size of fish, but the space available seems to be even more important.

In summary, it can be said, contrary to the remarks by Vaas and Hofstede, that *T. mossambica* reproduces well in sea water with a salinity of 36.2 parts per thousand, the growth of the fishes in sea water aquaria is the same as in fresh water aquaria, and that the number of spawnings per year is the same in water with salinities above 30 parts per thousand as it is in fresh or brackish water. The only difference observed is in the size of the fish. Whereas a specimen of *T. mossambica* in fresh water in a jar of 100 x 50 x 60 cm reaches a length of twenty cm and a weight of about 100 g at the age of nine months, the maximum size observed in a salt water aquarium of the same dimensions is ten cm and a weight of fifty g at the age of ten months.

No experiments have yet been made to cultivate these laboratory-born salt water *Tilapia* in the salt water inland bays of the Netherlands Antilles. However, this will be done in the near future.

LITERATURE CITED

Chimits, P.

1955. *Tilapia* and its Culture. A Preliminary Bibliography. F.A.O. Fish. Bull. 8(1):1-33, figs. 1-2.

1957. The *Tilapias* and Their Culture. A Second Preview and Bibliography. F.A.O. Fish Bull. 10(1):1-24, figs. 1-7.

Vaas, K. F. and A. E. Hofstede

1952. Studies on *Tilapia mossambica* Peters (ikan mudjair) in Indonesia. Contr. Inl. Fish. Res. Stat., Djakarta-Bogor, 1:1-68, ill.

Research and Interpretation of Marine Areas of the U. S. National Park Service

ORTHELLO L. WALLIS
Aquatic Biologist, National Park Service
Washington, D. C.

THE NATIONAL PARK SERVICE is actively concerned with the preservation, conservation and interpretation of typical ocean and seashore areas within the United States. A number of national parks and monuments contain such marine areas.

Colorful coral gardens are located in the Dry Tortugas of Fort Jefferson National Monument and off the shores of the Virgin Islands National Park. A variety of coastlines are represented at Acadia National Park, Maine; Cape Hatteras Nationl Seashore Recreation Area, North Carolina; Everglades National Park, Florida; San Juan National Historic Site, Puerto Rico; Glacier Bay National Monument, Alaska; Hawaii National Park; Olympic National Park, Washington; Virgin Islands National Park and Channel Islands National Monument, California.

Specific biological and physical features and scenic attractions of each make them unique and representative examples of the Nation's marine and seashore resources. In several other national historic sites and national monuments, the marine features are of secondary significance. Additional areas are currently being investigated for possible addition to the system. Each proposed area must fill a definite need and must be considered of national significance.

The National Park Service has conducted surveys along the Atlantic, Gulf and Pacific Coasts to determine the current status of the "vanishing shorelines." These investigations have classified the use of each portion of the coast, the significance of each section of unoccupied beach and inshore areas and the potential for their recreational and scientific use. Unexploited shorelines are disappearing at an astounding rate while the recreational requirements of a growing nation are expanding. Needs for preservation by federal, state, county and city governments of superlative and suitable areas are recognized.

The National Park Service is obligated to protect and preserve the areas within national parks and monuments and the features therein for the use and the enjoyment of the people. The biological features are maintained under conditions as nearly undisturbed and natural as possible.

Animal and plant forms are rigidly protected. Hunting is not permitted. Sport and commercial fishing activities in marine waters are allowed under restrictions which will protect the basic natural marine environments and fishes.

In addition to sport fishing by hook and line, skin-diving, underwater photography and exploring, fish watching, nature study, boating, swimming, sun bathing, and picnicking are other recreational activities enjoyed. Spear fishing and the collecting of plant, animal, or mineral specimens are not permitted in marine areas of the National Park System except for authorized scientific purposes.

It is vital to determine the extent of permissable recreational activities and areas in which each can be conducted. Adequate research of the marine and shoreline environments is necessary to make such determinations.

Investigations may show that the coral gardens and other marine habitats in

certain waters within the parks and monuments are in such a delicate balance that the elimination or restriction of recreational activities may be necessary in order to preserve these habitats. These would be considered as marine area sanctuaries. Considerable international interest in underwater parks is being developed.

Recent popular books, articles, movies and television programs have created nationwide enthusiasm and interest in the oceans and their inhabitants. Tens of thousands of Americans have donned fins and faceplates and gone beneath the surface to see for themselves; some have been content to learn from the study and experiences of others. The use of SCUBA (self-contained underwater breathing apparatus) equipment is rapidly becoming popular in these activities.

Visitors to our marine national parks and monuments are fascinated by these subjects and are requesting more and accurate information about the underwater world and life along the seashores.

Through interpretive services and research, the National Park Service is attempting to meet the current demands and is making plans for measures to fulfill future requirements. This is part of Mission 66, the ten-year program to develop and staff the entire System so that the needs of a much greater number of visitors may be met. At the same time the wilderness, scenic, scientific and historic resources entrusted to it must be fully safeguarded.

Along the shorelines of the Ocean Strip in Olympic National Park, and along the coasts of Acadia and Virgin Islands National Parks and Cape Hatteras National Seashore, park naturalists lead visitors on conducted seashore trips. On such treks, the story of the sea is unfolded and the life forms are identified and their ecological relationships are explained.

The marine-life story is further interpreted through illustrated talks, campground programs, and museum exhibits in several of these parks.

Planning for marine interpretation is just beginning. Initial ideas for underwater viewing methods and devices, marine museum exhibits, conducted services and popular publications are being developed.

Among these ideas are: underwater trails through representative marine gardens along which visitors could walk in the shallow waters and observe the undersea features through face plates or viewing boxes; open moats which extend along the shore or out into the water, where viewing would be through portholes; piers or docks which contain glass bottom wells extending over reef and shoreline areas so that visitors can observe beneath surface.

Other services being considered include conducted underwater trips, and boat trips using glass-bottom or glass-sided vessels. Underwater closed television circuits and audio pickups to transmit underwater scenes and noises may help bridge the barrier between terrestrial man and life in the sea.

Additional museum exhibits featuring the marine and shoreline stories are being designed. Although the Service prefers the entirely natural display of living things, aquaria may be the answer in some situations.

Popular publications and illustrated check lists will further assist the visitor in acquiring a greater understanding and appreciation of the marine life.

Research now being conducted and needed is directed toward providing information necessary for the formulation of regulations which will protect fish populations and marine habitats, for increased knowledge of the life histories and ecology of the marine forms, for accurate interpretive planning, and for actual interpretation of the marine resources.

Some research is sponsored by the Service through its appropriations but much research is done in cooperation with other federal and state agencies, educational institutions and independent investigators.

Some Service sponsored research is conducted by park personnel and other projects are conducted through contracts with qualified research institutions. Aside from financial participation, the Service is frequently in the position of being able to assist in other ways such as by providing housing, laboratory and storage space, transportation, and various services.

The National Park Service welcomes and encourages cooperative research not only on marine subjects but also on other phases of biology, geology, archaeology and history. Most parks afford ideal conditions for such study under conditions which have a minimum amount of disturbance by adverse land and water uses. Research activities can be expanded to fulfill the desires for basic information and the needs of the National Park Service.

Projects which are underway or are anticipated for the coming year are briefly described as follows:

Everglades National Park

Marine Fisheries Research

Both commercial and sport fishing is permitted by law in Florida Bay and adjacent waters of the park. Under a contract with the National Park Service, the University of Miami Marine Laboratory is conducting research to determine fishing facilities, majors fishing areas, estimates of total fishing pressure, catch, and catch per unit of effort, species and fishing methods.

Other phases of this study include a survey of the area, its physical and biological features. This detailed information is necessary for the formulation of fishing regulations which will protect the basic resource.

A three-year project to broaden the scope of the initial program is planned to start next year, pending necessary appropriations. The identification, life histories and other phases of biology of the fishes and other organisms in these waters will be given special emphasis in the proposed project.

Ecological Studies in Florida Bay and Other Coastal Brackish Waters

These inshore areas are of great significance to the valuable shrimp fishery out of Key West on the "Tortugas grounds." Studies of the juvenile and larval shrimp and the environment of the nursery grounds are being investigated by the University of Miami Marine Laboratory with the sponsorship of the Florida State Board of Conservation. In addition to the shrimp tagging program of the Laboratory, the U. S. Bureau of Commercial Fisheries has recently initiated a shrimp marking project in waters of the park.

The National Park Service has been able to assist with these projects by providing housing and other facilities for the research teams.

Fort Jefferson National Monument

Tortugan Marine Life Survey

Special emphasis on the marine ecology of the marine gardens of the Dry Tortugas will be given special attention in a National Park Service project programmed for next year if funds become available. Based upon past investigations and new studies, an overall type map of the marine communities will be constructed and check-lists and descriptive keys of the marine fishes, inverte-

brates and plants will be developed. This research will serve as the basis for planning the interpretive program.

Virgin Islands National Park

Virgin Islands Cooperative Marine Research Project

With its colorful and accessible coral gardens, the waters off the Virgin Islands National Park on St. John Island provide an excellent opportunity for interpretation of the life on the coral reefs. Little information of the life in the inshore waters of this area is available upon which to base a satisfactory program of management, protection and interpretation. Sport fishing is a potentially important recreational activity.

Late this summer, initial work on a three-year program of cooperative investigation of these waters was started. The basic financing is being provided by the Virgin Islands Government with its portion of Federal Aid in Sport Fish Restoration funds which are administered by the Bureau of Sport Fisheries and Wildlife. The Governor has contracted with the University of Miami Marine Laboratory to carry on the actual investigative work. The National Park Service, with a donation from the Jackson Hole Preserve, Incorporated, is providing various facilities such as a work boat, housing, laboratory and storage space and other facilities and has undertaken the project planning and direction. Project Leader Dr. John Randall also will conduct related studies in the St. John Island area on the ecology of coral reef fishes. These studies are being sponsored by a grant from the National Science Foundation.

Channel Islands National Monument

Biological Inventory and Survey

Long Beach State College has started an inventory and survey of the biological features of the Channel Islands National Monument. This investigation will include studies of the marine environments and marine life.

Olympic National Park

Intertidal Animal Research, Olympic Ocean Strip

This project, sponsored by the National Parks Association, will provide the National Park Service with information on the life of the shoreline area of the ocean strip. It will result in scientific collections for park use, information needed in museum and interpretive planning and material for a popular publication.

Cape Hatteras National Seashore Recreation Area

A Study of the Distribution of the Marine Fauna of Sound and Oceanic Waters in the Vicinity of Cape Hatteras, North Carolina. Cape Hatteras has long been known as the major division point in the distribution of many marine organisms. Many West Indian species find their northern limits here and boreal species terminate their southern distributions in this locality. An investigation to determine the distribution of the two faunal groups present and their movements at different times of the year is being conducted. This work is being directed by Dr. I. E. Gray of Duke University and is financially supported by a grant from the National Science Foundation. National Park Service funds have been used to provide certain necessary facilities.

Information on the marine fauna and ecology will prove important in the

museum and interpretive programs within the area. Fishing is a major activity within this recreational area and fishermen will benefit from the project findings, also.

DISCUSSION

Caribbean and General Session

Discussion Leader: Paul E. Thompson
Discussion Panel: Ernest Hess, W. D. Heydecker
John Gehringer, Durbin Tabb

The Recreational Potentials of the Marine Fisheries

Daniel Janzen

Q. Tabb: Could you comment on the possible hazards of pesticides on marine fisheries?

A. Janzen: This question of pesticides is bothering us more and more every day; in the last six months we have been getting very worried. You all know about the fire ant control program here in the South. That has focused attention on the problem. But we had an indication during the past two years that we were dealing with a sort of Frankenstein, such as we have in the case of radioactivity. Pesticides are accumulating in the bodies of warm blooded animals or in their food and it is having an effect on reproduction. What it is going to do to marine sports fisheries, I don't know, but I expect it will be very serious. The need for pesticide research is very great.

Q. Hess: In your work do you come in conflict with commercial fisheries?

A. Janzen: The philosophy of those supporting the commercial fishery program and those supporting the recreational program are quite different but the biology of the fish is the same. The habitat for both is the same, too, and the most important thing is to save that habitat.

Q. Heydecker: Is it not time to make some effort to find a common basis for a comparison of the economic value of fish caught by anglers with the economic value of fish caught by commercial fishermen? Such value of the commercial fishery has been computed customarily on the basis of the market value of the fish when landed, but in the determination of the value of the sport fishery, all the ancilliary factors of expenditures by anglers for travel, lodging, meals, tackle and bait, etc., have been brought into the picture. Therefore, the comparisons have not been on the same basis. Would you consider this a useful area of research?

A. Janzen: Yes, I certainly would. The basic philosophy determining the value of recreational fish and wildlife has been that it is worth what the public is willing to pay for it. If the commercial fishermen haven't taken that viewpoint in their computation of the value of the fish, then they should.

Q. Brady: How much of the Dingle-Johnson money has gone into research for marine sport fisheries?

A. Janzen: The Dingle-Johnson program is financed with the excise tax on sport tackle. There are 22 D-J projects in eleven states, and in Alaska, Hawaii, Guam, Puerto Rico, the Virgin Islands, aimed wholly or partly at marine sport fishing. The total cost of the salt water projects is $388,000 as of October 15, 1958. The total cost of the D-J Fish Research Program of all kinds is a little over $3,000,000, so that about 12 per cent of the D-J money is going into salt water marine fish research.

Q. Howard: How much of the Dingle-Johnson money comes from the sale of salt water fishing gear and how much from fresh water fishing gear? I am under the impression that a very large proportion of the funds come from tackle sold to salt water fishermen and yet only 12 per cent goes to salt water research.

A. Janzen: The state conservation departments plan and carry out the projects, and they have to pay 25 per cent of it; they finance the whole thing and we pay back 75 per cent of the cost. It is probably natural that if a state does not have salt water angling licenses it will be reluctant to put fresh water angling receipts into marine fisheries research, unless they are very broadminded and looking to the future.

Canning Tuna in Puerto Rico

ROLF JUHL

Q. Tabb: Where do the fish come from which are canned in the Ponce area?

A. Juhl: Surface-caught tuna come from the Pacific, but the Japanese are catching some by long-line in the Atlantic and Caribbean. About 30 per cent of our fish comes from the latter source and we would like to develop a tuna fishery in the Caribbean and tropical Atlantic. We have at the present time one ship fishing off Africa, which has been fishing for a month and a half and has close to 200 tons aboard. This is good news because it is the first U. S. ship that has gone there to fish. Undoubtedly if the trip is successful more boats will go there when the season is poor in the Pacific.

Q. Gehringer: Why do you bring tuna from the Pacific to Ponce instead of to San Diego?

A. Juhl: There are three reasons. It is about 3,000 miles from the fishing areas to San Diego and it is only about 1,200 miles to Puerto Rico. Transportation of the finished product from

Puerto Rico to the East and Gulf states is cheaper than by rail from California to the East and Gulf states. Finally, labor costs are lower in Ponce.

Q. Mather: Do you expect a major shift of the tuna industry from California to Puerto Rico?

A. Juhl: A large company from the West Coast has been looking over the island for a possible cannery site. If they move, some other canners from the West Coast might set up a base there.

Q. Mather: What species of tuna are brought in to your cannery?

A. Juhl: We only receive two species, the skipjack and the yellowfin. Sometimes the Japanese bring in some bigeye tuna, but these generally are too large for packing. They are also undesirable because of their color, which varies from pale green to orange, and sometimes tan and brown.

Q. Whiteleather: How many tuna clippers are there operating from your plant, and are there any local plant boats at Ponce?

A. Juhl: We have ten clippers, and six of these are the largest in the entire fleet. There is no local fishing boat unloading in Puerto Rico. Tuna fishing boats are quite elaborate, and the fisheries in the Caribbean would have to develop considerably to make it feasible for the local fishermen to catch tuna. One of the important factors in a tuna fishery is availability of bait. The islands are poor as baiting areas. The bait requirements of long-line fishing are less severe, but they would still need a costly boat.

Q. Zaneveld: Can you tell us something more about the Japanese operation?

A. Juhl: They started developing the long-line fishery in the Pacific. When their catches in the Pacific declined they extended their operation to the Indian Ocean. Now they are in the Atlantic, where I believe they have twenty boats. Until recently they had two boats in the Caribbean; now they might have more.

Laboratory Experiments in Raising Tilapia in Salt Water

JACQUES S. ZANEVELD

Q. Tabb: In these areas where you are contemplating introducing *Tilapia* are there not native species which might be equally acceptable as food?

A. Zaneveld: None of the native fish, for example, the white mullet, *Mugil curema,* and the grey mojarra, *Gerres cinereus,* reproduce as rapidly as *Tilapia* does.

Iversen: (Comment) It might be of interest that the U. S. Fish and Wildlife Service, Pacific Oceanic Fishery Investigations at Honolulu, have found the *Tilapia mossambica* to be quite good as tuna bait. There is a problem in the islands of obtaining sufficient native bait for skipjack fishing. Recent tests on commercial vessels have shown that *Tilapia* possesses sufficient de-

sirable qualities as a bait fish to suggest that this species may supplement the supply of wild bait.

Ecological Diagnosis of a Species and the Problem of Biological Constants

G. L. Kesteven, Horacio Rosa, Jr. and S. J. Holt

Q. Gehringer: Taxonomists use morphology predominantly in the descriptions. Will it not take a very long time before we have enough ecological information on which to base a species description?

A. Rosa: For some species probably it will; however, for some others, particularly from the north Atlantic, there is considerable data, which may be sufficient for a biological diagnosis of the species. The morphological concept is basic and it is necessary. But by adding a biological diagnosis, even if the species can change from environment to environment, in size or in other factors, we may be able to establish limits for the range of these changes.

Q. Rae: Dr. Rosa has left with us a stimulating idea which I am sure we will all want to think about a good deal, particularly after we can study his suggestions in more detail. But at first thought, I am left with the impression that ecological diagnosis is rather the end point than the means to the end; one may have to know all the facts before it can be meaningful. For example, for comparing the plaice and the flounder, I believe the following criteria were proposed: geographical limits, habitat, reproductive habit and life span. Now, it might be suggested that all these, to a greater or lesser degree, are influenced by fishing pressure in an area like the North Sea. Thus, man-made changes such as the intensity of fishing, the type of gear used, etc. will vary the diagnostic criteria and so the definition of the species. In a case of this sort, one may be categorising the economy of a fishery rather than any natural attributes of the fish.

A. Rosa: That may be, but I wonder if the fisheries will completely change the biology of the species. It may be, however, that we will have to change the definition, but this in itself will be valuable data for the understanding of the biological changes caused by stress of fishing.

Research and Interpretation of Marine Areas of the National Park Service

Orthello Wallis

Q. Whiteleather: You have a problem of water in the National Park, and we are also concerned with this in connection with commercial fishery nursery grounds. It appears that there is

considerably more water needed in the Park than they have at the present time.

A. Wallis: This is one of the major problems confronting us in Everglades National Park. It must be solved before it is too late.

Experimental Trawling for Red Snapper

WARREN RATHJEN

Q. Gehringer: Does the gear necessary for this type of trawling require any modification of the shrimp vessels so that they could be used for snapper fishing in the off season?

A. Higman: Yes, modifications would be required. For example, the replacement of standard shrimp rigging with the fore and aft gallows frames and a new winch were the only modifications required to successfully convert a St. Augustine type shrimp trawler to fish trawling in the New England area. The changes necessary would not be too expensive. The present system used by the shrimp vessels involves two outboard booms butted directly on the mainmast and this arrangement is not sufficiently sturdy for snapper trawling.

Q. Hess: What proportion of your catches were of red snappers compared with less desirable species?

A. Bullis: The best snapper fishing areas generally produce very clean catches of snapper. The principal saleable fish caught with them is grouper.

Participants

Gulf and Caribbean Fisheries Institute

Arata, George F., Jr.
Snyder and Black Co.
White Plains, N. Y.

Aska, Donald Y.
Fish and Wildlife Service
Washington, D. C.

Bacher, Kurt
Smith Research and Development Co.
Lewes, Delaware

Bailey, B. W.
Jacksonville Freezers
Jacksonville, Fla.

Barber, T. A.
J. Howard Smith Co.
Port Monmouth, N. J.

Barnes, J. T.
Brunswick Navigation Co.
Southport, N. C.

Barr, James E.
Shrimp Association of the Americas
Brownsville, Texas

Bevis, Charlie
Southeastern Fisheries Assn.
Tallahassee, Fla.

Brady, Winfield H.
Gulfarium
Ft. Walton Beach, Fla.

Broadhead, Gordon C.
Inter-American Tropical Tuna Comm.
La Jolla, California

Browning, R. A.
Gibbs Corporation
Jacksonville, Fla.

Bullis, Harvey R.
Fish and Wildlife Service
Pascagoula, Miss.

Carinhas, John Santos, Jr.
Patterson Shrimp Co., Inc.
Brownsville, Texas

Carr, Waggner
Lubbock, Texas

Chang, Pao-Shue
Taiwan, China

Chapman, Wilbert
American Tunaboat Assn.
San Diego, California

Chipman, Walter A.
Fish and Wildlife Service
Beaufort, N. C.

Clark, Eugenie
Cape Haze Marine Laboratory
Placida, Florida

Clark, Oliver J.
Valley Fisheries, Inc.
Port Isabel, Texas

Clegg, R. E.
R. E. Clegg "Trawlers"
Port Lavaca, Texas

Costello, Thomas J.
Fish and Wildlife Service
Coral Gables, Fla.

Croker, Robert
The Marine Lab., Univ. of Miami
Miami, Fla.

Dempsey, Henry Varner
Department of Fisheries of Canada
Ottawa, Ontario, Canada

Dobkin, Sheldon
The Marine Lab., Univ. of Miami
Miami, Fla.

Downes, Kenneth M.
Oyster Institute of North America
Beaufort, N. C.

Drinkard, John P.
Atlantic States Marine Fisheries Comm.
Lincolnton, Ga.

Drucker, Benson
The Marine Lab., Univ. of Miami
Miami, Fla.

Dubrow, David L.
The Marine Lab., Univ. of Miami
Miami, Fla.

Duggan, J. Roy
SeaPak Corporation
St. Simons Island, Georgia

Dumas, E. N.
Daniel and Dumas Seafoods, Inc.
Port Lavaca, Texas

Ebert, John F.
C.I.T. Corporation
Jacksonville, Fla.

Envoldsen, Karl
Envoldsen Shrimp, Inc.
Tampa, Fla.

Erdman, Donald S.
Department of Agriculture and Commerce of Puerto Rico
Lajas, Puerto Rico

Fender, D. L.
Gibbs Corporation
Jacksonville, Fla.

Ferlisi, Fred
The Marine Supply and Oil Co.
St. Augustine, Fla.

Ferguson, John C.
St. George Packing Co.
Fort Myers, Fla.

Ferreira, Hector
Pesquera y Industrializadora de Guaymas
Guaymas, Mexico

Finucane, John H.
Fish and Wildlife Service
St. Petersburg Beach, Fla.

Fosdick, C. H.
Gibbs Corporation
Jacksonville, Fla.

Foulk, Howard
The Marine Lab., Univ. of Miami
Miami, Fla.

Galtsoff, Paul S.
Fish and Wildlife Service
Woods Hole, Mass.

Garcia, Manuel Zepeda
Camara Nacional de la Industria Pesquera
Mexico, D. F.

Gehringer, Jack W.
Fish and Wildlife Service
Brunswick, Ga.

Godfrey, Walter J.
Western Shell Fish Co., Inc.
Harlingen, Texas

Gordon, J. C.
Gibbs Corporation
Jacksonville, Fla.

Gresh, Walter
Fish and Wildlife Service
Atlanta, Ga.

Gunn, Dudley
Gulf States Marine Fisheries Comm.
New Orleans, La.

Hagar, Antonio
Camara Nacional de la Industria Pesquera
Mexico, D. F.

Hall, Y. E.
Y. E. Hall Insurance Agency
Fernandina Beach, Fla.

Hardee, Will
Brownsville, Texas

Hargis, William J., Jr.
Virginia Fisheries Laboratory
Gloucester Point, Va.

Haynie, R. L.
Haynie Menhaden Products
Wildwood, N. J.

Hess, Ernest
Ministry of Natural Resources and Agriculture of the West Indies Federation
Port-of-Spain, Trinidad

Hettler, Washington H.
Fishing Gazette Publishing Corp.
New York, N. Y.

Heydecker, Wayne
Atlantic States Marine Fisheries Comm.
Mt. Vernon, N. Y.

Higman, James B.
Fish and Wildlife Service
Washington, D. C.

Hobson, Ben A.
D. C. A. Foods, Inc.
Webster Grove, Mo.

Hollahan, George L., Jr.
Florida House of Representatives
Tallahassee, Fla.

Holston, Jack
Fish and Wildlife Service
Washington, D. C.

Howard, John K.
The Marine Lab., Univ. of Miami
Miami, Fla.

Idyll, C. P.
The Marine Lab., Univ. of Miami
Miami, Fla.

Robert M. Ingle
Fla. State Board of Conservation
Tallahassee, Fla.

Iversen, Edwin S.
The Marine Lab., Univ. of Miami
Miami, Fla.

Jackson, Charles E.
National Fisheries Institute
Washington, D. C.

Janzen, Daniel H.
Fish and Wildlife Service
Washington, D. C.

Jean, Raymond, G. R.
French Government Representative
Martinique

Johnson, Mack
Newman Lynde and Associates
Jacksonville, Fla.

Jones, Andrew E.
The Marine Lab., Univ. of Miami
Miami, Fla.

Juhl, Rolf
National Packing Co.
Ponce, Puerto Rico

Julich, Fred
Fort Myers Shrimp Assn.
Fort Myers, Fla.

June, Frederick C.
Fish and Wildlife Service
Beaufort, N. C.

Kahn, Walter
The Marine Lab., Univ. of Miami
Miami, Fla.

Kausnicka, Edward T.
Gorton's of Gloucester, Inc.
Atlanta, Ga.

Kazmi, M. A. S.
The Marine Lab., Univ. of Miami
Miami, Fla.

Khandkes, Alam
The Marine Lab., Univ. of Miami
Miami, Fla.

Klima, Edward F.
The Marine Lab., Univ. of Miami
Miami, Fla.

Kline, Edward F.
American Cyanamid Company
Princeton, N. J.

Koczy, Fritz F.
The Marine Lab., Univ. of Miami
Miami, Fla.

Kreutzer, Conradin O.
Smith Research and Development Co.
Lewes, Delaware

LaMonte, Francesca R.
American Museum of Natural History
New York, N. Y.

Leffler, Ross
Department of the Interior
Washington, D. C.

Lentz, Henry R.
H. M. Hillman Brass & Copper Co.
New Orleans, La.

Letson, Stanley W.
Maine Marine Products, Inc.
Portland, Me.

Levinson, Leo D.
Ocean Products, Inc.
Tampa, Fla.

Long, E. John
The International Oceanographic Foundation
Miami, Fla.

Lord, David B.
Southern Fisherman
Jacksonville, Fla.

Love, Travis
Pascagoula Fisheries Laboratory
Pascagoula, Miss.

Lunsford, William C., Jr.
Reedville Oil and Guano Co., Inc.
Wildwood, N. J.

McCarthy, Keith
Department of the Interior
Washington, D. C.

McConnell, James L.
Bay Towing and Dredging Co.
Mobile, Ala.

McGinnis, Harry I.
Wallace Menhaden Products, Inc.
New Orleans, La.

McKee, Donald H.
Tampa Shrimp Producers Association, Inc.
Tampa, Fla.

McKernan, Donald L.
Bureau of Commercial Fisheries
Washington, D. C.

McPherson, Benjamin
The Marine Lab., Univ. of Miami
Miami, Fla.

Madero, Daniel C.
Camara Nacional de la Industria Pesquera
Mexico, D. F.

Madero, Mauricio
Camara Nacional de la Industria Pesquera
Mexico, D. F.

Malton, George B.
Amerio Contact Plate Freezers, Inc.
Cliffside Park, N. J.

Manning, Raymond
The Marine Lab., Univ. of Miami
Miami, Fla.

Marchand, C. J.
Gibbs Corporation
Jacksonville, Fla.

Marra, David
The Marine Lab., Univ. of Miami
Miami, Fla.

Mather, Frank J., 3rd
Woods Hole Oceanographic Institution
Woods Hole, Mass.

Mehos, John A.
Shrimp Association of the Americas
Galveston, Texas

Meitin, H.A.
St. Augustine National Bank
St. Augustine, Fla.

Menzel, R. Winston
Florida State University
Tallahassee, Fla.

Meyer, Max
Meyer Fish and Produce Co.
Jacksonville, Fla.

Miller, Nick
Shrimp Peeling Machine Co., Inc.
Hialeah, Fla.

Moffett, Alan
The Marine Lab., Univ. of Miami
Miami, Fla.

Mohiuddin, S. Q.
The Marine Lab., Univ. of Miami
Miami, Fla.

Mowbray, Louis S.
Government Aquarium and Museum
Flatts, Bermuda

Neblett, William R.
National Shrimp Congress
Key West, Fla.

Nelson, Donald
The Marine Lab., Univ. of Miami
Miami, Fla.

Nybakken, James
The Marine Lab., Univ. of Miami
Miami, Fla.

Obarrio, Juan L.
Ministerio de Agricultura,
Comercio Industrias, Republic
of Panama
Panama City, R. P.

Oliver, W. T.
Naches, Texas

Oswald, Erling
Food and Agriculture Organization
Manta, Ecuador

Peace, Harry L.
H. L. Peace Publications
New Orleans, La.

Pierce, E. Lowe
University of Florida
Gainesville, Fla.

Poli, D. J.
The Marine Supply Co.
St. Augustine, Fla.

Rae, Kenneth MacF.
Texas A. & M.
Bryan, Texas

Ramirez, Raul
Productos Refrigerados, S. A.
Carmen, Mexico

Randall, John E.
The Marine Lab., Univ. of Miami
Miami, Fla.

Reintjes, John
Fish and Wildlife Service
Beaufort, N. C.

Ringhaver, L. C.
Diesel Engine Sales, Inc.
St. Augustine, Fla.

Robas, John S.
Fernandina Beach, Fla.

Robida, Anthony J.
Florida Fish Distributors, Inc.
Jacksonville, Fla.

Robins, C. Richard
The Marine Lab., Univ. of Miami
Miami, Fla.

Roman, Erl
The Marine Lab., Univ. of Miami
Miami, Fla.

Romo Castro, Fco. Javier
Camara Nacional de la Industria
Pesquera
Mexico, D. F.

Rosa, Horacio, Jr.
Food and Agriculture Organization
Rome, Italy

Rosen, Albert
The Marine Lab., Univ. of Miami
Miami, Fla.

Rosenberg, Gerald
Atlas Foods, Inc.
New York, N. Y.

Rosenberg, John H.
Florida Fishermens Supply Co.
Tampa, Fla.

Rounsefell, George A.
Fish and Wildlife Service
Galveston, Texas

Saenz, William
The Marine Lab., Univ. of Miami
Miami, Fla.

Sahlman, D. M.
Sahlman Seafood Co.
Tampa, Fla.

Sahlman, Harry F.
Sahlman Seafoods
Fernandina Beach, Fla.

Sanchez, Manuel
Brownsville Shrimp Exchange
Brownsville, Texas

Sanchez, Thorvald
Havana, Cuba

Sanches Roig, Mario
Institute Nacional de la Pesca
Havana, Cuba

Schafer, Henry
The Marine Lab., Univ. of Miami
Miami, Fla.

Schoenborn, Henry W.
University of Maryland
College Park, Md.

Swartz, Max
East Coast Fisheries
Miami, Fla.

Siebenaler, John B.
Gulfarium
Ft. Walton Beach, Fla.

Simmons, W. R.
W. R. Simmons Research, Inc.
New York, N. Y.

Singleton, Henry
Singleton Packing Corporation
Tampa, Fla.

Smith, F. G. Walton
The Marine Lab., Univ. of Miami
Miami, Fla.

Smith, Gilbert P.
A. Smith Meal Co.
Long Island, N. Y.

Smith, Warren
Caterpillar Tractor Co.
Jacksonville, Fla.

Snodgrass, Sam M.
Magic Valley Processing Co.
Port Isabel, Texas

Stark, O. H.
Snyder and Black Co.
White Plains, N. Y.

Stevens, Roy C.
Fish and Wildlife Service
Jacksonville, Fla.

Stewart, Kenneth
The Marine Lab., Univ. of Miami
Miami, Fla.

Stock, Charles W.
National Freezers, Inc.
Miami, Fla.

Strasburger, Lawrence W.
Metairie, La.

Sturgis, Howard O.
National Fisheries Institute
Washington, D. C.

Styron, Jack T.
Wallace Menhaden Products, Inc.
New Orleans, La.

Tabb, Durbin
The Marine Lab., Univ. of Miami
Miami, Fla.

Talbot, Gerald B.
Fish and Wildlife Service
Beaufort, N. C.

Thomas, Lowell
The Marine Lab., Univ. of Miami
Miami, Fla.

Thomassin, Maurice
Cia de Productos Crustaceos
Panama City, R. P.

Thompson, John R.
Fish and Wildlife Service
Pascagoula, Miss.

Thompson, Paul E.
Fish and Wildlife Service
Washington, D. C.

Traeger, Leo P.
Columbian Bronze Corp.
Freeport, N. Y.

Tweedy, John
The Marine Lab., Univ. of Miami
Miami, Fla.

Udell, Lawrence
Gulf Stream Quick Frozen
Foods, Inc.
Miami, Fla.

Vance, Mary H.
The Marine Lab., Univ. of Miami
Miami, Fla.

Versaggi, M.
Versaggi Shrimp Co.
Tampa, Fla.

Versaggi, Virgil
Versaggi Shrimp Co.
Brownsville, Texas

Villers, Robert H.
St. George Packing Co., Inc.
Fort Myers, Fla.

Volpe, Alfred V.
The Marine Lab., Univ. of Miami
Miami, Fla.

Voltz, Jeanne
The Miami Herald
Miami, Fla.

Voss, Gilbert L.
The Marine Lab., Univ. of Miami
Miami, Fla.

Wallace, David H.
Oyster Institute of North America
Annapolis, Md.

Waller, Wayne M.
H. J. Baker & Bro.
New York, N. Y.

Wallis, Orthello L.
National Park Service
Washington, D. C.

Wangersky, Peter
The Marine Lab., Univ. of Miami
Miami, Fla.

Warren, Zygmunt
Shrimp Association of the Americas
Mexico, D. F.

Watson, L. W.
Pearl Island Seafood Co.
Pearl Island, R. P.

Wheeler, Murray
National Fisheries Institute
Washington, D. C.

Whiteleather, Richard T.
Fish and Wildlife Service
St. Petersburg Beach, Fla.

Wilmot, M. D.
Gibbs Corporation
Jacksonville, Fla.

Wood, E. Day
Shoreline Enterprises of
America, Inc.
Tampa, Fla.

Zaidi, S. H.
The Marine Lab., Univ. of Miami
Miami, Fla.

Zaneveld, Jacques S.
Caraibisch Marien-Biologisch
Institut
Curaçao, N. A.

Zoa, William
Taiwan, China